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THE NEW YORK CONVOCATION

THE meeting of the American Association for the Advancement of Science and the affiliated national scientific societies held in New York City during the last week of the year was the largest and most important gathering of scientific men hitherto held in this country or elsewhere. The association met in twelve sections and there were fifty-two separate societies in session, not counting the four great engineering societies, which held one general meeting with the association. It is difficult to estimate the attendance. The registration of members of the association was in the neighborhood of 2,100, but it is impossible to state the percentage of members of the association who register, or the percentage of those in attendance at the meeting who are members of the association. Casual observation seemed to indicate that about one in four or five attending the meetings wore the badge of the association and this would give an attendance of over 8,000, but naturally very little weight can be laid on such an estimate. In spite of the magnitude of the meeting, Columbia University and the other places in which sessions were held did not appear

to be overcrowded, the university and the other educational and scientific institutions of the city having grown in proportion to the increase of scientific men since the meeting in New York ten years ago. There was no delay in registration and no difficulty in obtaining rooms at the hotels or elsewhere. There was a very great conflict, in so far as there were nearly always a number of different meetings or other events which members would have been glad to attend. This conflict may make a greater impression than if the meetings were being held in fifty different places throughout the country, but obviously the real interference is much less.

The plan of holding the greater convocation week meetings once in four years seems to have been justified by the event. The meeting four years hence will be in Chicago, that of eight years hence in Washington, and in twelve years there will be a return to New York. It may be that ultimately two events in the same year, the presidential election and the convocation of our scientific societies, will be recognized as of comparable national importance. It is hoped that at these greater convocation week meetings the societies devoted to the natural and exact sciences will meet with all national organizations concerned with science in its widest sense, not only engineering and medicine, but also education, economics, history, philology and indeed all the subjects falling within the curriculum of the modern university, subjects which can be advanced by research. A meeting of such magnitude would have great advantages in bringing together men working in diverse directions but none the less having common objects, and would serve the purpose of impressing on the general public the magnitude and importance of the work accomplished in this country for scholarship and science.

The American Association of University Professors and the American Congress of Internal Medicine met this year for the first time in convocation week, and there is no reason why all national societies should not do so when the meeting is in New York, Chicago or Washington. The arrangements for affiliation with the association are very simple, and apparently to the advantage of all. The affiliated society has the privilege of meeting with the association when it sees fit and of electing one or two members of the council of the association. The association has no control of any kind over the affiliated society. Even when the affiliated society does not meet at the same time and place as the association, it is desirable that there be held once a year a congress representing all the scientific societies and scientific interests of the country, and it seems that the council of the association can serve this purpose better than any other body. The National Academy of Sciences, a small self-perpetuating body, consisting of men elected for eminence in science at the average age of about fifty years, may be of use as a roll of honor, but it can scarcely be expected to be an efficient working body, and it is not so well in accord with democratic conditions as a body of delegates elected to represent the scientific societies and the scientific men of the country.

The executive, legislative and judicial functions of government are recognized, but it is scarcely yet appreciated that there should be a scientific or expert department coordinate with these. As the courts theoretically interpret legislation and the executive carries it into effect, so there is needed a body which will provide the impartial advice and scientific knowledge on which legislation should be based. This need is being gradually recognized by the creation of scientific bureaus of the departments and the different government commissions. Its adequate appreciation may, however, be hastened by the formation of a body representing the scientific interests of the country and competent to speak for them.

The various scientific events of the meeting are in part recorded in the report of the general secretary printed in this issue of SCIENCE and in the programs that were published in advance. They will also be somewhat fully represented by the various addresses and papers and by the proceedings of the different societies and sections to be printed in SCIENCE. A few of them, however, may be recorded here. At the opening general session, after the admirable address of the retiring president, Dr. W. W. Campbell, director of the Lick Observatory, there was a largely attended reception given by the president and trustees of the museum and the honorary reception committee. The two public lectures to the citizens of the city could hardly have been better from the point of view of subject-matter or of lecturer. Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute, lectured at Columbia University on "Infantile Paralysis and the Public Health," and Dr. A. A. Noyes, professor of physical chemistry in the Massachusetts Institute of Technology, lectured at the American Museum of Natural History on "Nitrogen and Preparedness." In each case the lecture concerned a subject of vital public interest and was given by the man most competent to survey it.

There was held at the United Engineering Societies Building a meeting under the auspices of the four engineering societies which have their headquarters in New York to discuss the interrelations of engineering and pure science. Dr. Henry M. Howe, the distinguished metallurgist, professor emeritus in Columbia University, the chairman of the section, presided, and Dr. Bion J. Arnold, the retiring vice-president and past-president of the American Institute of Electrical Engineers, gave his address, which was followed by addresses by Mr. Clemens Herschel, president of the American Society of Civil Engineers, and Dr. Ira D. Hollis, president of the American Society of Mechanical Engineers. The scientific session was followed by a reception.

The addresses given by the other retiring chairmen of the sections are noted in the report of the general secretary and may be looked for in SCIENCE. Other addresses by the presidents of the societies and papers presented before them will also be printed here. Of the latter, it is only possible to mention several of the symposiums and general-interest sessions. These included "Biology and National Existence" before the American Society of Naturalists; "The

Structure of Matter" before the sections of physics and chemistry; "The Relations of Chemistry to Botany" before the section of botany; "The Adjustment of Science to Practise in Agriculture" before the section of agriculture; "Cancer and its Control" before the section of physiology and experimental medicine; "Highway Engineering" before the section of engineering; Reports of State Geologists before the section of geology and geography; the Metric Conference before the section of social and economic science; and the celebration of the twenty-fifth anniversary of the American Psychological Association.

There was held at Columbia University a scientific exhibit and conversazione arranged under the auspices of seventeen committees, representing the principal sciences. This not only showed in an interesting way some of the more recent scientific developments, but also served as an excellent place for people working in different departments to meet. There was also held at the American Museum of Natural History an exhibit of chemical "preparedness," and one on the work of Pasteur. In addition there were numerous exhibits arranged by the special societies.

There were many dinners and social events. Tea was served daily by the Columbia University Ladies Committee. The smoker given by the New York Zoological Society in the Aquarium to visitors working in the natural sciences was especially attractive, but every society and group had its smokers and dinners. Among them may be specially mentioned the dinner in honor of Professor Edmund B. Wilson, of Columbia University, a former president of the association, given by his students and colleagues.

The meeting of the Committee of One Hundred on Scientific Research, in spite of the fact that it was held the day after Christmas, was attended by about fifty members and was notable for important reports and discussions. The report of the committee on industrial research was presented by Dr. Raymond Bacon, director of the Mellon Institute for Industrial Research, and the discussion was opened by Dr. J. J. Carty, chairman of a similar committee of the National Research Council, and by Dr. F. K. Richtmyer, chairman of a similar committee of the American Physical Society. Preliminary reports were made by eleven of the chairmen of the twelve sub-committees on the different sciences, all of whom were present. Arrangements were adopted for cooperation with the National Research Council.

The meeting was much better reported in the press than ever before. It is true that on one day when from two to three hundred scientific papers were presented, many of them of general interest if properly interpreted for the public, there were selected for head lines one that referred to birth control and one that referred to the Rev. Billy Sunday, but for the first time adequate attention was paid to the meeting, which obtained a position on the front page and was suitably discussed in editorial articles. This circumstance is of course accounted for by the increased interest now taken in science throughout the world, and it is much to be hoped that for the welfare

of the world this interest may be maintained. A meeting such as this should have as one of its principal functions to impress on the general public the importance of scientific research, for it is only from the people at large that new recruits for science can be obtained and means provided for the support of research.

The council discussed business of importance. Two general resolutions were adopted. One advocated a greater use of the metric system of weights and measures in the United States, "so as to increase the usefulness of our publications and to aid our foreign relations with the many countries where these units are official and in use." The other extended to the secretaries and bureau chiefs of the United States government the appreciation of the association of the fact that through their encouragement the important scientific work under their direction has been well represented at the meetings of the association. "This representation has greatly promoted the influence and usefulness of the bureaus, both by making their work more widely known, and by the stimulus imparted to and gained from other workers in similar fields. The association is so keenly interested in the work of the government bureaus that it ventures to express the hope that members of their staffs who are engaged in research be given all practicable encouragement to attend the meetings of the association and other national and international organizations devoted to the advancement of science."

Thanks to the Colburn bequest, the research funds of the Association have been greatly increased and now amount to about $110,000. During the year careful investments have been made by a committee consisting of the treasurer, Dr. R. S. Woodward, president of the Carnegie Institution, Mr. A. S. Frissell, president of the Fifth Avenue Bank, and Mr. John Tatlock, of New York City. Some part of this fund is reserved for specific purposes, but the balance of the income, amounting to about $4,000, was appropriated for allotment for scientific research, and a committee on grants of seven was appointed, representing the principal sciences and groups of sciences. This committee consists of Professor E. C. Pickering, chairman, mathematics and astronomy, Professor Henry Crew, physics, Professor E. C. Franklin, chemistry, Professor W. B. Cannon, zoology and physiology, Professor N. L. Britton, botany, and Professor J. McKeen Cattell, anthropology and psychology, leaving one vacancy to be filled by a geologist. The committee plans to make a careful study of the conditions in order to determine how the money can be expended to best advantage. Applications for grants will, however, be welcomed; these can be made to the chairman of the committee or to the member in charge of the subject concerned.

An appropriation was made for the work of the Pacific branch of the association, amounting to the entire dues paid by the members within the division except that required to pay for the journals that the members receive. The entrance fees collected by the branch were also allotted to it. There was recently established through

the initiative of Professor H. L. Fairchild, a local branch at Rochester, and it is hoped that other branches will be established wherever they will serve to unite and advance the scientific interests of a city or locality. To such local branches, a sum not to exceed fifty cents for each member of the branch was allowed, together with the entrance fees secured through the efforts of the branch.

The council had pleasure in acknowledging gifts for the research fund of the association of $1,000 from Mr. E. D. Adams, and of $500 from Mr. Cleveland H. Dodge. In accordance with the provisions of the constitution, Mr. Adams was elected a patron of the association. If a hundred or a thousand men of means in this country whose wealth is in large measure due to the efforts of scientific men made more efficient by their national societies would become patrons of the association there would be provided a productive fund for research administered by scientific men themselves, and the relations of science to industry would be promoted. At the meeting about three hundred citizens of the city became members of the association, and of these a considerable number became life members, including Mr. Henry C. Frick, Mr. Stuyvesant Fish, Mr. Felix M. Warburg, Mr. James W. Ellsworth, Mr. Francis L. Stetson and others prominent in the professional and business life of the city.

The committee on policy was instructed to prepare a revision of the constitution, with by-laws, and to report to the council at its next stated meeting. The committee on policy was instructed in this revision especially to redefine the duties of the permanent secretary and of the general secretary. An amendment to the constitution was introduced, which will be voted on next year, making the term of office of the general secretary five years, and it is planned that the general secretary shall be active in the work of the organization of the association in its relation to the affiliated societies and the general scientific activity of the country. Professor J. McKeen Cattell was elected to this office, to which no salary is attached.

During the present year in order to recognize the cooperation that exists between the American Association and the affiliated societies, members of these societies who joined the association during the year were admitted without payment of the entrance fee. The results were particularly gratifying in demonstrating the cordial relations existing between the association and the national societies, as about 5,000 members of these societies took advantage of this offer and were elected to membership during the year. We hope to publish later a statement showing the number of scientific men from each of the affiliated societies who joined the association, for it is a remarkable exhibit of the number of men in this country engaged in scientific work. When the association met in New York City in 1900, there were about 1,700 members; when it met there in 1906, there were about 5,000 members, there are now about 12,000 members. The entrance fee of $5 prevents some of the younger scientific men of limited means from joining the association, but it seems necessary to retain it to provide an income in addition to the very small annual dues

of $3, and also because it makes the membership more permanent, members hesitating to withdraw for a short time when such a fee must be paid to resume their membership. The council, however, passed a resolution providing that those becoming members of the national affiliated societies might be elected to membership in the American Association without payment of the entrance fee, if they join the association within one year of becoming a member of the affiliated society. This offer should give assistance to the affiliated societies as well as the association, and should serve to unite in the association almost without exception the younger scientific men of the country.

The nation should be proud of its scientific men when it regards the three presidents of the association, the retiring president, the president of the meeting and the president elect. Dr. W. W. Campbell, director of the Lick Observatory, who has twice crossed the continent to attend the meetings and has devoted his invaluable time to the organization of the Pacific Division, gave the address as retiring president, which in content and in form of presentation set a model which any similar officer anywhere in the world will find it hard to meet. This address will be printed in SCIENCE as soon as arrangements can be made for the illustrations. Dr. Charles R. Van Hise, president of the University of Wisconsin, in the front rank of geologists in a country which leads in geology, and equally a leader in university education and in movements for the public welfare, made an admirable presiding officer, both in the general sessions and at the meetings of the council. Dr. Theodore W. Richards, director of the Wolcott Gibbs Memorial Laboratory, Harvard University, distinguished wherever chemical research is undertaken, the only native-born American to whom a Nobel prize in science has been awarded, was elected to preside at the meeting to be held next year at Pittsburgh and to give the address the following year in Boston.

PRODUCTIVE SCIENTIFIC SCHOLARSHIP[1]

I WARMLY sympathize with the ambition expressed in your annual report to have this musem more than a mere zoologic or scientific museum. It should be a museum of arts and letters as well as a museum of natural history. The ethnology and archeology of the Indians of New York make up a subject peculiarly apparent for treatment in a museum of this character. There should be here a representation of all our colonial and revolutionary life. There should be in this museum, for the instruction and inspiration of our people, a full representation of American history since the time when New York cast off its provincial character and became an integral portion of the American republic. Finally there should be here all the representation possible of the great arts and great literatures of the nations of the past, and the nations of the present; so that, enriched by the knowledge of what has been done elsewhere, in time and in space, our own people shall be better equipped to work in the fields of original productive scholarship.

All this lies in the future. At present we have only to do with biology.

A museum of this character has more than one function to fulfil. It must pre-

[1] Address delivered at the opening of the New York State Museum in the State Education Building, Albany, N. Y., on the evening of December 29, 1916.

sent to the people as a whole in vivid and yet truthful form, knowledge of the natural objects of our countryside—that is, knowledge of nature—in such a fashion as to be readily understood.

Moreover, it must aid in the study of nature—that is in the study of soils, insects, plants, birds and mammals—from the utilitarian standpoint.

Again, it must aid the growing army of nature students, the men and women who love nature, or love science, for the sake of nature or science, without any set and immediate utilitarian purpose. This museum should keep aloft the standard of those who delight in all knowledge and all wisdom that can not be reduced to, or measured by, any money scale.

Finally, this museum should perform the even more difficult task of giving research facilities to the extraordinary and exceptional student, the man who has in him a touch of the purple; the man who can supply that leadership without which it is so rare for even the laborious and well-directed work of multitudes of ordinary men to realize the ideal of large productive achievement.

Little can be done save by cooperation and coordination. We are fortunate in this state to have at the head of our educational system, in President Finley, a man whose ability to work by himself goes hand in hand with ability to work with others, and with ability to train up others to work under him; and who does all this in such fashion as to produce the maximum of benefit to the people as a whole. No man has done more than he has done to secure for New York City a broadening of the standard of cultivation, so as immensely to increase the number of persons who can profit thereby, and at the same time to provide for the needs of those exceptional men and women who, if given the chance, will do work of such exceptional character that, to the permanent impoverishment of mankind, it will remain undone unless these exceptional persons are permitted to do it.

It is essential that this museum should command the services of many different men for work in many different fields, and that its work should be so closely related to work of the same kind elsewhere that it shall all represent a coordinated whole. This is true of all departments of its work, but especially so of those departments which have a direct utilitarian bearing. It is the farmer who benefits most from the utilitarian type of zoological work. The rising generation will see a great change in the position of the farmer in our social economy; our governmental activities are already in process of being turned to this end. Most of the initial difficulties of connecting the farmer in fruitful fashion with the government have been at least partially overcome. The book man and the closet man now understand that their science is worthless unless subjected to the test of actual conditions of life and labor. And on the other hand the farmer has begun to understand that the most practical rule-of-thumb man can profit by a wise use of the learning of the soil expert, the plant expert or the expert in the knowledge of fungi and insects. It is essential that the work of this sort in each state should be hitched on to the work in other states, and in the federal capital, if the best result is to be obtained.

In addition to this science which is of direct utilitarian bearing, to this knowledge of nature which can be scientifically applied to economic and agricultural betterment, there is science pursued for its own sake. There is a twofold warrant for the encouragement of the study of pure science by the state.

In the first place, the knowledge justifies itself. The scientific student is justified

because he studies science, if he studies for a serious purpose, exactly as is true of the man of arts, or the man of letters. Mere addition to the sum of the interesting knowledge of nature is in itself a good thing; exactly as the writing of a beautiful poem, or the chiseling of a beautiful statue is in itself a good thing. A nation that does not understand this is not wholly civilized; and a democracy that does not understand this can not claim to stand abreast of such a democracy as Athens in the past and France in the present.

In the next place, the greatest utilitarian discoveries have often resulted from scientific investigations which had no distinct utilitarian purpose. Our whole art of navigation arose from the studies of certain Greek mathematicians in Alexandria and Syracuse, who had no idea that their discoveries would ever have a direct material value. It is impossible to tell at what point independent investigation into the workings of nature may prove to have an immediate and direct connection with the betterment of man's physical condition.

Most of the men and women, indeed the immense majority of the men and women, who work for pure science, can not aspire to the position of leadership; exactly as most business men can not expect to press into the ranks of the captains of industry. Yet each can do work which is not only creditable and useful, but which may at any time become literally indispensable, in helping to discover some great law of nature, or to draw some great conclusion from the present condition, or from the former physical history, of the world. This museum, like all similar institutions, should do everything possible to develop large classes of workers of this kind.

We must never forget, however, that the greatest need, and the need most difficult to meet, is to develop great leaders, and to give full play to their activities. Of course it must also be our aim to develop men who, if they do not stand on the heights of greatness, shall at least occupy responsible positions of leadership.

In the entirely proper effort to develop numbers of individual workers, there must be no forgetfulness of the need of individual leadership, if American achievement in the scientific field is to be really noteworthy. In the scientific (as in the historical) associations and academies this fact is sometimes forgotten. Undoubtedly much that is indispensable has been done, and much more can be done, in the field of historical research by the collaboration of numbers of men. But really great works will never be produced by such collaboration. The really great works must be produced by an individual great man, who is able to use to the utmost advantage the indispensable work of a multitude of other observers and investigators. He will be the first to recognize the debt he is under to these other observers and investigators; if he does not do so, he will show himself a poor creature. On the other hand, if they are worth their salt they will be proud to have the great architect use all the results of their praiseworthy and laborious and necessary labor in constructing the building which is to crown it.

Darwin's epoch-making work would never have been done had not the foundation been laid deep and wide by many acute and faithful observers. But it needed the man of masterly genius to produce the great work.

I need hardly say that insistence upon the need of men of towering genius to do the supreme, the epoch-making work, does not in the least mean that there is not utmost need of first-class work of the ordinary type by the rest of us, who are just ordinary men. The best library is a mighty

poor library unless the immense majority of the books are by men who are not of epoch-making genius; and in any community in which much first-class scientific work is being done the bulk of it will be to the credit of men who do not pretend to belong to the highest category. In the scientific, as in every other field of endeavor here in the United States, there is ample room for the man who can not be called a genius but who can do capital work. Nevertheless, it remains true that the third-rate man can not produce first-rate work and that from the standpoint of the world, while it is well to help or train the third-rate man to do his third-rate work well, what is of most importance is to give the first-rate man the training and the apparatus to do the first-rate work, which, unless he does it, will not be done at all.

Let me give my statement more precision by speaking of just one small corner of the scientific field, that with which I am most familiar—the study of ornithology and mammalogy. In these fields there is need for work by experts who are only closet workers. But there is far more need of work by field naturalists. Most of all there is need of work by trained laboratory men who also possess a wide field experience. As regards mammals, there is still a good deal of work to be done in mere collecting, but even as regards mammals, and infinitely more as regards birds, the days of the supremacy of the mere collector have passed. This is true even of the least known parts of the earth, and is infinitely more true here of New York. The man who merely collects multitudes of bird skins or mammal skins, and then goes over them with laborious minuteness in the study, for the purpose of a classification which really represents primarily a fetishistic adoration of a highly conventional and technical trinomial terminology, must always occupy a humble, and may readily occupy a merely useless, position in the scientific world. The ordinary pamphlet describing new subspecies and even new species, differentiated from one another by trifling characteristics, represents work which it is true possesses a slight usefulness; but it is a usefulness not entitling the author to a grade much above that of the man who totes bricks in a wheelbarrow. Ninety-nine times out of a hundred these little pamphlets are of interest exclusively to rival, and equally unimportant, pamphleteers with slightly different views on terminology, and on trivial questions of subspecific differences. Generalizations based on sheer imagination or on imperfectly observed facts or on entirely insufficient data are at best useless, and are apt to be mischievous. Any type of honest work by the intellectual brick-collectors and wheelbarrow men is better than such dishonest attempts to pass off castles in the air as productive real estate. But mere vast collections of minute facts, which in themselves are of trivial importance, without any attempt to explain and correlate these facts, and without cautious wisdom to generalize from them, are of strictly limited usefulness.

Study of the interrelations of the lines of descent among birds and beasts is of absorbing interest. Study of the comparative effect of environment and heredity on physical structure is no less interesting. There must be ample research in the laboratory in order even to present these problems, not to speak of solving them, and there can be no laboratory study without the accumulation of masses of dry facts and specimens. I do not for a moment mean that there should be any failure to recognize the need of such accumulation of facts. But I do mean that there should be an equally clear recognition, that the ac-

cumulation of facts is only the beginning; that it is only laying the foundation on which the man of high ability must rear the superstructure. I also mean that from now on it is essential to recognize that the best scientific men must largely work in the great out-of-doors laboratory of nature. It is only such out-doors work which will give us the chance to interpret aright the laboratory observations.

In the New York State Museum Bulletin, published last July, there are pictures of two birds, once common in America, now totally extinct. One is the passenger pigeon and the other the Labrador duck. The passenger pigeon formerly existed in this state in millions, and the Labrador duck was common off the coast. The passenger pigeon has been exterminated through sheer brutal, reckless, and largely wanton, slaughter, by our so-called civilized people. The Labrador duck became extinct from causes of which we are absolutely ignorant. There are plenty of stuffed specimens of both in museums. But in the case of neither do these stuffed specimens throw any real light on the birds' life history. As regards the Labrador duck, we shall in all probability never know the particulars of its life history, nor the causes of its sudden extinction. As regards the passenger pigeon, in its physical structure (which in its essentials is strikingly like that of our common mourning dove) there is nothing which would give the least hint of its extraordinary habits, of the innumerable myriads in which it moved fitfully hither and thither over the land, and of the enormous extent of its shifting nesting sites. There is now no other bird in the world with such habits; and the stuffed specimens that remain of it do not, all put together, begin to equal in value the written records dealing with it in such old-style natural histories as those of Wilson and Audubon. There are many points in its life's history which are still obscure, and these points are obscure chiefly because so few of the many ornithologists, who abounded in this country at the time of its extinction, had any idea that their closet work in museums was of no consequence whatever compared to a thorough and careful life study of the passenger pigeon. The extinction of the passenger pigeon is a blot on our civilization (and let me remark parenthetically that every society of this kind should be a focus of effort to prevent any of the birds we still have from following in the wake of the passenger pigeon); but, inasmuch as it is extinct, it is well for us to remember that we owe an incalculable debt to the observers who have left for us a record of its life history, whereas we owe only a very small and easily calculated debt to those who merely collected specimens of it for their collections.

Let the scientific man realize that he must be a good first-hand observer of wild things in their native haunts, if he is to stand in the first rank of his profession. Let him also remember that it is his business to write well! Of course, he can not be expected to write as well as John Burroughs; but he ought to have writings like those of John Burroughs before him, to represent the ideal toward which he strives. Let him strive to do original work, the work of original productive scientific scholarship.

The New York Zoological Park, under the guidance of Dr. Hornaday, the American Museum of Natural History in New York, under the guidance of Mr. Osborn and Mr. Chapman, have furnished models in this matter. The three gentlemen named have done original productive scientific work of the highest value, at the same time that they have in every way popularized—not cheapened!—science, and made the present and the past life history of this

planet accessible in vivid and striking form to our people generally. Their assistants have done hazardous and exceedingly interesting and important work in the wildest of the waste spaces of the world. It has been my privilege to journey through the East Central African wilderness and the Brazilian wilderness in company with outdoor faunal naturalists—Mearns, Heller, Cherrie, Miller, Loring—and myself to witness the hazard and the high value of their work; and last winter I visited in Demerara Mr. Beebe's really extraordinary field laboratory for intimate biological research in the tropics, and I count it one of the privileges and pleasures of my life to have worked with these men.

Theodore Roosevelt

DEDICATION OF THE CERAMIC ENGINEERING BUILDING OF THE UNIVERSITY OF ILLINOIS

On December 6 and 7, the University of Illinois, dedicated its new ceramic engineering building. The dedication exercises were opened at 1.30 P.M. on Wednesday, December 6, by a meeting of the advisory board of the department, followed by a reception in the building, at which all of the laboratories were thrown open to the visiting guests and the university public.

On the evening of Wednesday an introductory session was held in the university auditorium, presided over by Dr. Edmund J. James, president of the university. At this session, Dr. S. W. Stratton, director of the National Bureau of Standards, gave an address on "The Ceramic Resources of America." This was followed by an address on "Science as an Agency in the Development of the Portland-Cement Industries," by Mr. J. P. Beck, general manager of the Portland Cement Association of Chicago. Dr. Stratton discussed the organization and formation of the different types of clay deposits together with their most prominent geological and geographical positions in the United States. This was followed by a discussion of the reactions occurring during the burning of clay products. A detailed classification of the various clay products fashioned from ceramic materials was also presented. The whole address gave a very clear idea of the great variety and extent of the clay resources of the nation and the multifold products which are manufactured from them.

The second dedicatory session was of a technical nature and assembled on Thursday morning in the university auditorium. It was opened with an address on "The Manufacturer's Dependence upon Ceramic Research" by Mr. W. D. Gates, president of the American Terra Cotta and Ceramic Company, of Chicago. This was followed by further discussions by Mr. Ross C. Purdy, research engineer of the Norton Company, and by Mr. L. E. Barringer, engineer of insulations for the General Electric Company. Mr. C. H. Kerr, who was to discuss the same topic from the standpoint of the problems of the glass industries, was unable to be present, but sent his discussion for presentation.

The second address of this session was given by Mr. W. W. Marr, chief state highway engineer of Illinois, upon the topic "The Use of Ceramic Materials in Highway Construction." This paper was discussed in a very interesting manner by Mr. Blair, secretary of the National Paving Brick Manufacturers' Association, of Cleveland, Ohio, and by Mr. G. G. Wooley, engineer for the Road Bureau of the Portland Cement Association, Chicago.

A paper on the topic "Ceramic Products as Structural Materials" was presented by Mr. H. J. Burt, structural engineer, of Chicago, and discussed by Mr. A. V. Bleininger, ceramic chemist and head of the clay products laboratory of the United States Bureau of Standards.

The last topic for discussion at this session was "The Use of Ceramic Products in the Artistic Embellishment of Buildings." The discussion was opened with a paper by Mr. Claude Bragdon, author and architect of

Rochester, New York, which was discussed by Mr. G. C. Mars, of St. Louis. Mr. F. Wm. Walker, who was to have discussed the same topic, was unable to be present.

At the close of the forenoon session, the speakers and guests of the university were entertained at luncheon at the University Club by the dean and heads of departments of the College of Engineering. The formal session of dedication convened at the university auditorium in the afternoon. It was presided over by Dean W. F. M. Goss, of the college of engineering. Introductory addresses were made by the Honorable Edward F. Dunne, governor of the state of Illinois, and by Honorable W. L. Abbott, president of the board of trustees of the University of Illinois. The principal address of this session was then given by Professor Charles F. Binns, director of the New York State School of Clayworking and Ceramics, upon the topic "The History of the Ceramic Arts." The exercises were closed with an address by the president of the university, describing the history of the growth of the department of ceramic engineering. After singing "America" the audience marched to the new building where the prayer of dedication was delivered by the Rev. John Mitchell Page.

On the evening of the 7th, an Illinois student branch of the American Ceramic Society was formally installed by Mr. L. E. Barringer, president of the society.

An illustrated booklet describing the department of ceramic engineering, its organization, purposes and equipment was published by the university for distribution at the dedication exercises.

"SCIENCE" AND THE COST OF PAPER

THE price of the paper on which SCIENCE is printed has increased from four and one quarter to ten cents a pound, and this makes the cost of supplying the fifty-two annual copies of SCIENCE to members of the American Association for the Advancement of Science greater than the amount paid for them, apart from editorial expenses and the cost of composition. Under these circumstances it is necessary to adopt one of three alternatives: (1) To use news print paper, which is difficult to obtain and is not durable; (2) to increase the subscription price, as has been done by the *Outlook,* the *Independent* and other journals, but an increase could not go into effect for a year, and it is to be hoped that the abnormal price of paper is temporary; (3) to diminish the size of the numbers. This, although regrettable, appears to be the least unfortunate of the alternatives, as the regular number of pages can be used when conditions become normal.

For the present, therefore, SCIENCE will be reduced in size to two sheets with a cover. The cover is used to improve the appearance of the journal, and is feasible because the cost of cover paper has not increased in proportion to the cost of book paper. The cover also permits trimming the copies without injury to the appearance of the journal. Hitherto trimmed and untrimmed copies have been sent to subscribers as requested, but this complicates the subscription list, and there seems to be a general opinion that the copies should be trimmed, in spite of the fact that untrimmed copies are preferred for binding. The most distinguished American efficiency expert remarked this week that if the time of scientific men should be estimated at its true value the cost of opening SCIENCE by hand would be over $10,000 a year.

In order to effect a further saving in paper the index and title page for the volume will be sent to libraries as usual, but only to individuals who apply for them. This plan is followed by other weekly journals, for the index is only of use to those who bind the numbers.

As has been already announced, members of the American Association whose dues are paid later than January 1, will receive the back numbers of SCIENCE only on payment of one cent a number to cover the extra cost of mailing. It can not be guaranteed that the copies will be supplied, as, owing to the cost of paper, only so many extra copies will be provided as are likely to be needed. The offices of the permanent secretary of the association and of SCIENCE will be greatly assisted by the prompt payment of dues.

SCIENTIFIC NOTES AND NEWS

At the meetings in New York last week, Professor George H. Shull, professor of botany in Princeton University, was elected president of the American Society of Naturalists; Professor Frederic S. Lee, of Columbia University, president of the American Physiological Society, and Professor Robert M. Yerkes, of Harvard University, president of the American Psychological Association.

Mr. E. B. Williamson has been appointed to the position of curator of Odonata in the Museum of Zoology, University of Michigan. He will retain his residence at Bluffton, Ind., and will direct most of the work in his department from there, making frequent trips to Ann Arbor to inspect the collections. Mr. Williamson is at present on a collecting trip in the Santa Marta Mountains, Colombia.

Mr. J. Alfred Hardcastle has been appointed to be astronomer to the Armagh Observatory in the room of Dr. J. E. L. Dreyer, who recently resigned to take up work at Oxford. Mr. Hardcastle is a grandson of the late Sir John Herschel, and has for many years been a university extension lecturer both for Oxford and Cambridge. The two distinguished occupants of the office who have preceded him—Dr. Dreyer and Dr. Romney Robison—held it for almost 100 years.

Irving Fisher, professor of political economy in Yale University, has been appointed lecturer on the Hitchcock Foundation for the fall of 1917 at the University of California. He will give a series of lectures on "Price Levels," between October 1 and 14, 1917.

Wallace Campbell, son of Director W. W. Campbell of the Lick Observatory, has been appointed teaching fellow in astronomy in the University of California, succeeding F. J. Neubauer, who becomes university fellow in the Lick Observatory.

Provost Edgar F. Smith, of the University of Pennsylvania, visited Wittenberg College, Springfield, Ohio, where he was professor of natural science in the early eighties and the Ohio State University, Columbus, O., Friday evening, November 24, where he delivered a lecture before the Columbus Section of the American Chemical Society on "Robert Hare, a Pioneer American Chemist."

The ninety-first course of Christmas lectures to juvenile audiences at the Royal Institution of Great Britain, which were instituted by Michael Faraday in 1826, are being given by Professor Arthur Keith, F.R.S., on December 28, 30, January 2, 4, 6 and 9, at 3 o'clock on each day. His subject is "The Human Machine which All Must Work." At a later date Professor C. S. Sherrington, F.R.S., will give six lectures on the old brain and the new brain and their meaning, and on pain and its nervous basis. The first Friday evening discourse will be given on January 19, when Professor Sir James Dewar will lecture on soap bubbles of long duration.

Dr. W. W. Keen, president of the American Philosophical Society, writes: "In the most impressive list of honors—so richly deserved—bestowed upon Professor Simon Newcomb as published by Mr. Archibald in your issue for December 22, 1916, there is one slight inaccuracy which I beg leave to correct. Under date of January 1, 1909, it is stated that Professor Newcomb was elected vice-president of the American Philosophical Society. Professor Newcomb was elected vice-president in January, 1905, and was re-elected every year up to and including 1909, the year of his death."

Dr. T. H. Bean, chief of the division of fish culture of the conservation commission of New York, and prominent in the work throughout the United States, died on December 28, in Albany, as the result of being struck by an automobile six weeks ago.

Dr. Claude L. Wheeler, editor of the New York *Medical Journal,* died on December 30, in Brooklyn.

Mr. Clement Reid, F.R.S., late of the British Geological Survey, died on December 16, at sixty-three years of age.

The death is announced of Mr. A. M. Worthington, F.R.S., formerly professor of physics at the Royal Naval College, Greenwich.

Mr. W. Ellis, F.R.S., formerly superintendent of the magnetical and meteorological

department, Royal Observatory, Greenwich, died on December 11, in his eighty-ninth year.

THE death is announced, in his eighty-sixth year, of Dr. Richard Norris, formerly professor of physiology in Queen's College, Birmingham.

REPORTS have reached this country of the death of Professor Max Lühe, of Königsberg, Prussia, in a field hospital in Russia, on May 3, 1916, at the age of forty-six years. Dr. Lühe's work in protozoology and parasitology is well known.

THE trustees of the Rockefeller Institute for Medical Research have passed the following vote:

Resolved: That in recognition of the decreased purchasing power of fixed salaries caused by the increased cost of living, an additional and special compensation, equal to fifteen per cent. of the current annual salary, be paid to each regular officer and employee of the institute, said sum to be paid on January 5, 1917; it being understood that this is not an increase of salary and does not create any precedent for the future. In the case of employees who have served less than one year the payment will be fifteen per cent. of the amount actually received up to December 31, 1916.

It is to be hoped that this resolution will be brought to the attention of trustees of all educational and scientific institutions.

PLANS are under way at the headquarters of the American Institute of Mining Engineers for the one hundred and fourteenth meeting of the institute to be held in New York from February 19 to 22 inclusive. It is expected that this meeting will bring out discussions of an important character regarding the development of mining methods in recent times and some of the immediate problems. About 500 mining engineers from many different parts of the world will be in attendance. Since the western meeting of the institute in September, its membership has increased by more than 200 members. In the past three years the enrollment has risen from 4,284 to 5,922. This increase is regarded as an important commentary on the development of mining in this country, the membership of the institute being limited to those engaged in mining, and metallurgical engineering, geology or chemistry. The officers of the American Institute of Mining Engineers are L. D. Ricketts, president; Sidney J. Jennings, first vice-president; George C. Stone, treasurer, and Bradley Stoughton, secretary.

THE *British Medical Journal* states that the Italian minister of war recently invited medical women to offer themselves for military service. Graduates of more than five years' standing are to have the rank of sublieutenant; those of more than fifteen years' standing that of captain. Signora Filomena Corvini is the first woman who has received a commission. She has been appointed to the 9th Army Corps for service at the front.

THE late Dr. Magnan, a former president of the Paris Academy of Medicine, has left to that body a sum of £1,000 to found a triennial prize to be awarded to the author of the best work on a psychiatrical subject.

IN her will Mrs. Mary Palmer Draper, who died on December 8, 1914, left gifts exceeding $450,000 to the New York Public Library and a legacy of $150,000 to the Harvard College Observatory, where she had already established the Draper Memorial. The report made by Appraiser Berwin reveals that the net estate amounted to $1,630,220 and is insufficient to pay the specific bequests in full. Accordingly they have been abated proportionately. The gifts to the New York Public Library as enumerated were: Books, portraits, engraved gems, etchings and engravings, $25,548 in value; cash bequests of $250,000, abated to $238,836, and a remainder interest in the trust fund for Rosin B. Palmer, $64,796 in value. The bequests severally were to found the John S. Billings Memorial Fund for the purchase of books and the Anna Palmer Draper Fund as a memorial to the decedent's father. The bequest to Harvard is abated to $143,301. Under the terms of the will this is to be expended in preserving and using the photographic plates of the Draper Memorial. Mrs. Draper gave her husband's plates and scientific apparatus previously loaned to the observatory. The Polyclinic Hospital, which was to receive $50,000, will get $47,767. The Children's Aid Society, the New York Association for Improving

the Condition of the Poor, the New York Skin and Cancer Hospital and the Laboratory of Surgical Research of the New York University, which were bequeathed $25,000 each, are apportioned $23,883. The Metropolitan Museum of Art will get art objects worth $21,830. Bequests to individuals are likewise reduced.

The faculty of medicine of Harvard University offers as usual this year a course of free public lectures, to be given at the Medical School, Longwood Avenue, on Sunday afternoons, at four o'clock. The program follows:

January 7.—Rev. Dr. Francis G. Peabody, "Alcohol and Efficiency."

January 14.—Dr. Hugh Cabot, "The Care of the Wounded with the British Expeditionary Force in France."

January 21.—Dr. E. W. Taylor, "Infantile Paralysis; Precautions Necessary and Unnecessary."

January 28.—Dr. W. T. Porter, "'Shock' in the Trenches."

February 4.—Dr. J. L. Morse, "Feeding and Its Relation to the Infant's Development."

February 11.—Dr. F. J. Cotton, "The Development of Employer's Liability Insurance in Accident and Sickness."

February 18.—Dr. E. H. Place, "Does it Pay to Have the Contagious Diseases during Childhood?"

February 25.—Dr. Percy G. Stiles, "Sleep."

March 4.—Dr. L. M. S. Miner, "Diseases of the Teeth and the Use of the X-ray in their Diagnosis and Treatment."

March 11.—Miss Ida M. Cannon, "Social Service in Medicine."

March 18.—Dr. Cleveland Floyd, "Tuberculosis; its Cause and Prevention."

March 25.—Dr. W. B. Cannon, "Methods of Medical Progress."

April 1.—Dr. C. T. Brues, "Fleas and Other Insect Parasites in Their Relation to Public Health."

April 8.—Dr. J. Bapst Blake, "Accident and Injury; First Aid" (with demonstration of simple methods and materials).

April 15.—Dr. Paul Thorndike, "Urinary Troubles in Elderly Men" (to men only).

April 22.—Dr. W. H. Robey, "Some Facts and Fancies about Heart Disease."

A series of popular medical lectures will be given at the Stanford University Medical School during January, February and March, 1917. The program is as follows:

January 12: "What Every One Should Know about Cancer," Dr. Harry M. Sherman, representing the American Society for the Control of Cancer.

January 26: "Modern Efforts to secure Painless Childbirth," Dr. Frank W. Lynch, professor of obstetrics and gynecology, University of California.

February 9: "Poliomyelitis," Dr. William C. Hassler, health officer of San Francisco.

February 23: "The Importance of Proper Habits of Carriage as a Basis of Health." Illustrated. Dr. Harry D. Langnecker, clinical instructor in orthopedic surgery, Stanford Medical School.

March 9: "The Problem of Race and Race Prejudice," Professor Arthur W. Meyer, professor of anatomy, Stanford Medical School.

March 23: "Prevention of Blindness." Illustrated. Dr. Hans Barkan, clinical instructor in ophthalmology, Stanford Medical School.

We learn from *Nature* that a meeting was held on November 9 in the University of Sheffield to discuss the formation of a Society of Glass Technology. The widespread interest in the scheme was demonstrated by the presence of representatives of cities as far apart as London, Edinburgh and Cardiff, whilst every glass-manufacturing district was well represented. Mr. W. F. J. Wood, of Messrs. Wood Bros., Ltd., Barnsley, was elected to the chair, and the meeting opened with a cordial welcome from the vice-chancellor of the university, Dr. H. A. L. Fisher, who remarked that Sheffield had cause for legitimate pride in the knowledge that its university had been proposed as the headquarters of a society representing such an important industry. He emphasized the fact that this industry, among others, had suffered in the past owing to its detachment, wholly or partially, from its scientific aspects. The formation of the department of glass technology in the university was serving to remedy this state of affairs, and the inauguration of this society was a distinct step in the same direction. Dr. W. E. S. Turner outlined the steps that had led up to the formation of the society, and spoke of the remarkable response from those interested in glass. Expressions of approval and promises of support had been received from all over the country. Dr. Turner pointed out that there was no

intention of making the society a local institution; but that it was in every way a national one. The report of the provisional committee was adopted, and a formal resolution giving actual being to the society was passed unanimously. The following officers were then elected: *President,* Mr. W. F. J. Wood; *Vice-presidents,* Mr. S. B. Bagley, Mr. F. J. Cheshire, Sir William Crookes, Mr. A. S. Esslemont, Professor H. Jackson, Mr. S. N. Jenkinson, Mr. H. J. Rowell, Dr. W. Rosenhain, F.R.S., Mr. H. J. Stobart, Dr. M. W. Travers, F.R.S., Mr. Duncan Webb and Mr. H. S. Williams-Thomas; Treasurer, Mr. F. Sweeting; *Secretary,* Dr. W. E. S. Turner; *Assistant Secretary,* Mr. C. J. Peddle.

IT is stated in the daily papers that the Federal Bureau of Mines has succeeded in producing radium which is worth $1,000,000 at market prices at a cost of $340,000. Most of this radium will go to the Memorial Hospital of New York and the private cancer hospital conducted by Dr. Howard A. Kelly, of Baltimore.

Now that it is possible to obtain photographic records of events of historical importance the question of preserving really valuable films is again engaging attention. Two difficulties stand in the way of securing a permanent national collection of films. One is the risk of fire owing to the inflammable character of the material used, and the other is the fact that the life of a cinematograph film is limited to a few years. According to the London *Times* the attention of the British Museum was recently called to the question of the permanent preservation of the cinema films illustrating the South Polar Expedition of the late Captain Scott. These films are shown by Mr. Herbert G. Ponting in his lecture "With Captain Scott in the Antarctic," which is now being given at the Philharmonic Hall. The director of the museum replied that the matter of preserving historic films had not been overlooked, but as special risk was incidental to the storage of films the trustees, in the interest of the national collections generally, felt disinclined to receive favorably such proposals. Preservation of the films taken of the fighting in the war is so desirable that it is hoped that some way of solving the existing difficulties may be found.

IN August the Congress of the United States appropriated $175,000 for the investigation of sources of potash within the United States. This appropriation was designed to make possible the continuation on a large scale of the work inaugurated and carried on by the Bureau of Soils of the U. S. Department of Agriculture. As a result of this work, and of the operations to date of the various commercial organizations engaged in the extraction of potash from kelp on the Pacific coast, it appeared to the officials of the Department of Agriculture that the giant kelps of the Pacific coast represented the largest and most immediately available source of potash in the country. Accordingly the secretary of agriculture has authorized the construction at some point on the coast of Southern California of a plant to be designed and operated to demonstrate on a commercial scale the various processes of extracting potash and by-products from kelp. This work will be carried on by the Bureau of Soils under the personal supervision of J. W. Turrentine. The bureau proposes to proceed at once with the execution of its plans.

THE white pine blister rust has been discovered in Minnesota in four localities along the St. Croix River, close to the eastern boundary of the state. A careful survey of other portions of the state last summer failed to disclose the presence of the disease elsewhere. It is believed that the infestation came from the adjoining state, Wisconsin, which in turn was first infested from a shipment of pines from Germany. An emergency appropriation was allowed to the Minnesota state entomologist, and field work, both survey and eradication, has been pushed during the past season. A special appropriation will be asked from the legislature this winter in order that the work may be continued for a number of years. It would appear that Minnesota has a good chance to stamp out the disease before it obtains a foothold.

THE New York *Sun* states that a suggestion is being made in England to establish a "cen-

tral department of minerals and metals" under government auspices to collect and impart information bearing on the sources of minerals and the production of metals, as being imperatively necessary in the public interest. This is advanced in a letter sent to the chairman of the "advisory council of scientific and industrial research" by the presidents of the "institution of mining engineers," "institute of mining and metallurgy" and "institute of metals." The letter points out that there is at present no connecting link between various organizations, that there is considerable overlapping and much waste and confusion. If a properly organized and efficiently conducted department of minerals and metals had been in existence much valuable time, many lives and vast sums of money would have been saved to the nation in the conduct of the present war, and much of the cost and inconvenience to British industries depending largely for their raw material on mineral products would have been saved. The following are some of the duties suggested by the new department: Arrangement for expediting the completion of mineral surveys of the United Kingdom and crown colonies and other British possessions. Systematic collection and coordination of information bearing on the occurrence, uses and economical value of minerals and their products; special attention being devoted to securing industrial applications for newly discovered minerals or metallurgical products and to finding mineral materials required for new metallurgical products or inventions.

According to *Nature* the *Gazette de Hollande* emphasizes the use made in Germany of geological advice in trench warfare, and Professor Salomon, of Heidelberg, is said to have urged the formation of a special organization of geologists in connection with the army. It is said that excellent use has been made by the British military authorities of the Geological Survey staff, members of which have been of technical assistance in fields as wide apart as the deeply dissected strata of Gallipoli and the undulating Cretaceous expanses of the Paris-Brussels basin. The geologist has been found of service in military mining as well as in questions of water supply, and the memoir recently issued by the Geological Survey on "Sources of Temporary Water Supply in the South of England and Neighboring Parts of the Continent" was drawn up specially to meet the needs of camps.

UNIVERSITY AND EDUCATIONAL NEWS

Muskingum College, New Concord, Ohio, has received an anonymous gift of $150,000 for endowment and buildings, on condition that the college pay an equal amount.

With the desire to encourage the study of Russian, in view of the commercial intercourse between Russia and Hull, Capt. H. Samman has expressed to the Hull Chamber of Commerce his willingness to start an endowment fund for the purpose with a sum of £10,000.

O. R. Sweeney, Ph.D. (Penna.), for the past six years instructor in qualitative analysis at the University of Pennsylvania has been appointed instructor in industrial chemistry at the Ohio State University where he formerly graduated from the chemical engineering course.

C. H. Snyder, the consulting structural engineer, has been appointed lecturer in civil engineering in the University of California.

DISCUSSION AND CORRESPONDENCE

PHOSPHATES

Some experimental results in a comparison of different phosphates at the Tennessee Agricultural Experiment Station have recently been referred to by Dr. C. G. Hopkins[1] in such a way as to be easily misunderstood. The writer wishes to say that neither now nor in the past have these results allowed us to advocate, as intimated by Dr. Hopkins, the use of unacidulated bone meal. From the standpoint of economy the data obtained here have been

[1] Science, p. 652, November 3, 1916.

decidedly in favor of acid phosphate as compared with either bone meal or phosphate rock. In Dr. Hopkins's article omission was made of the fact that in the table referred to —Bulletin 90, p. 89, Tennessee Agricultural Experiment Station—every $1.00 invested in acid phosphate gave on the average a calculated profit of $4.28 where the cowpea crops were turned under, and of $5.42 where they were removed for hay. Phosphate rock, on the other hand, gave by a similar calculation a profit of only $2.58 where the pea crops were turned under and the same amount where they were removed for hay. These results are the average of three series of experiments, one conducted for five years at the Knoxville Station, another conducted for four years at the Ford farm in Knox County and the third conducted for three years at the Weaver farm in Warren County.

C. A. MOOERS
AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF TENNESSEE

SOIL SOLUTION

IN an article on "Acidity and Adsorption in Soils as Measured by the Hydrogen Electrode,"[1] Sharp and Hoagland truly say, as far as the literature is concerned, "Our present methods do not enable us to study the soil solution itself" (p. 127), but the writer hopes that the Van Suchetelen and Itano method as developed in this laboratory will forward this study. Description of this method will be published soon by this station. The soil solution thus obtained is considered as closely representing the one in the soil. The writer is using this soil solution for bacteriological studies of soils and sees no reason why it should not be used in the study of other soil conditions. This method by which sufficient solution can be obtained for the study of chemical composition, physical properties, etc., should be an aid in the study of soil fertility.

J. FRANKLIN MORGAN
AGRICULTURAL COLLEGE EXPERIMENT
STATION,
EAST LANSING, MICHIGAN

[1] *Journal of Agricultural Research,* Vol. VII., No. 3, 1916, pp. 123–143.

OLIGAEROBE, HISTANAEROBE

THERE has lately come into use the word microaerophilic[1] to designate the oxygen requirements of a class of microorganisms (*Meningococcus, Gonococcus, Bacillus abortus*) that require free oxygen for their growth, but which succeed best only when the oxygen is in less amount than it is in the atmosphere.

From the etymologic standpoint, the word appears fairly satisfactory, although μικρός is more applicable to smallness of size than quantity. It seems unfortunate that a word based on the form of the well-established aerobe and anaerobe was not coined. In its place I would suggest the word oligaerobe, from 'ολίγος, meaning few, with special reference to number or quantity.

For organisms like *Treponema pallidum* that require a small piece of sterile tissue added to the medium in addition to anaerobic conditions, the word histanaerobe would appear to be a suitable designation.

M. W. LYON, JR.
GEORGE WASHINGTON UNIVERSITY

[1] Dorland, The American Illustrated Medical Dictionary, p. 580, 1916. Cohen and Markle, *Jour. Amer. Med. Ass.,* Vol. 67, p. 1302, October 28, 1916.

FILEABLE ANNOUNCEMENTS OF NEW BOOKS

TO THE EDITOR OF SCIENCE: One who receives the numerous advertising circulars of book publishers is often at a loss to decide how much of this material to keep and how to file it, and the result is that when some particular information is wanted it is not always easy to get at it quickly. Having found the card system such a time and labor saver for such data as needs filing in a chemical laboratory, I have long wished that I might have a catalogue of all new books bearing on the subjects in which I am interested. It has seemed to me that the publishers in general would gain much if, instead of sending out the usual leaflets and circulars which vary in size and make-up as widely as the territory over which they are scattered, they would send out 3 × 5 cards giving the complete title, name of author, size of book, number of pages and of illustrations, table of contents, and a short paragraph indicating the scope of the work. If all publishers

sent out their information about new books in this form, the recipients could file the cards in any way which fitted their needs best and could feel reasonably sure of being able to find quickly the necessary information, when the need should arise. Printing some of the information on the reverse of the card should not be objectionable. One or two publishers have recently done a little along this line of advertising and doubtless many teachers have wished that publishers would introduce the plan generally. I am sending you this information in the hopes that publishers of educational books may have their attention brought to the desirability of putting their announcements in the form suggested. It should be a good business investment for them.

WILHELM SEGERBLOM
DEPARTMENT OF CHEMISTRY,
THE PHILLIPS EXETER ACADEMY,
EXETER, N. H.

QUOTATIONS

THE WORK OF THE AMERICAN ASSOCIATION

THE meeting in New York this week of the American Association for the Advancement of Science and fifty other affiliated national scientific societies, is an event which ought to loom large in the minds of thoughtful people. Not only do the thousand papers and reports read at the various section meetings themselves represent a large part of recent scientific achievement, but the meeting and exchange of views between men occupied in different fields can not but stimulate and liberalize the great human effort to conquer the jungle of ignorance and prejudice that surrounds the little clearing of cultivated science. Yet despite the fact that the meeting this week gives due prominence to the chemical conditions of "preparedness," and other matters affecting our national prosperity, it does not seem likely that it will do much to shake the massive apathy toward the spread of science and scientific method which characterizes our educated classes. A large part of this apathy is due to the vague but widespread feeling that science no longer needs any champions, that since the days of Tyndal, Huxley and Youmans, it has conquered and taken possession of all our educational institutions.

Nothing could be farther from the truth. Compared with the provisions for scientific research in countries like France and Germany, ours are pitifully meager. The energy of our colleges and universities is primarily directed to increasing the number of students, buildings and degrees conferred. The professors are so loaded up with routine teaching and such an unconscionable amount of administrative work, that he who would engage in genuine scientific research must do so by stealth and at the expense of his health. Nor do we provide many incentives for that kind of work. The public reward and recognition extended to technologic promoters is out of all proportion to that extended to scientific achievement itself—witness the millions of people who have heard of Edison but not of Theobald Smith, or who think that Marconi invented wireless telegraphy. Probably thousands of Yale men have not heard of Willard Gibbs, one of the most creative minds in nineteenth-century science, whose work at New Haven was possible largely because he was a man of means and of good family. Perhaps the general cause of science might prosper more in this country if there were greater cooperation and less provincial isolation among the various groups of specialists. Thus the great meeting in New York this week is marked by the absence of all the social science associations, which meet in Columbus, Ohio. The separation between the social and the physical scientists can surely not be of any real advantage to either. At any rate the great outstanding and deplorable fact is that on the vital questions requiring their cooperation, *e. g.*, the effect of immigration or of the interbreeding of races we have multitudes of impassioned orations and sophomore essays, but nothing worthy of being called science. Thousands upon thousands of studies have been devoted by the historians to the German migrations of the fifth century. Can it be that recent events because we are in a position to know more about them are necessarily of lesser intrinsic importance?—*The New Republic.*

SCIENTIFIC BOOKS

Lectures on Nutrition—delivered under the Auspices of the Washington Academy of Sciences. Published at Washington, D. C., 1916.

This is a reprint, in collected form, of a series of four published lectures given under the auspices of the Washington Academy of Sciences, during April, 1916, with which is included, as an introduction, the address of the retiring president of the Chemical Society of Washington, Dr. C. L. Alsberg, which was given before a joint meeting of the Chemical Society and the academy.

The address of Dr. Alsberg, entitled "The Biochemical Analysis of Nutrition," reviews recent contribution to the knowledge of the component parts of the food elements and their fate in metabolism, especial attention being given to the investigations of the rôle of amino acids in nutrition.

"The Basal Food Requirement of Man," by E. F. DuBois, considers the basal energy requirements of man, the manner in which metabolism is studied, and the factors by which it is influenced under conditions of health and disease.

"Nutrition and Food Economics," by Graham Lusk, gives statistical data regarding the amount of protein and the fuel value of food consumed by people living under extremely varied conditions. This lecture also refers to a dietary study, carried out by F. C. Gephart, in a private boarding school for boys. The author also emphasizes the need of including on the label of package foods the number of calories furnished by their contents.

"Investigations on the Mineral Metabolism of Animals," by E. B. Forbes, presents some of the conclusions, with reference to the rôle of mineral elements of foods, which were drawn from extensive studies of the chemistry of foods and metabolism experiments with swine and milch cows, data being included regarding the iodin content of foods.

In "The Relation of the Vitamins to Nutrition in Health and Disease," by C. Voegtlin, the author outlines recent advances in the science of nutrition, with special reference to the importance in the diet of small amounts of the so-called accessory food substances essential for the maintenance of health. The topics considered are the deficiency disease, beriberi; the chemical isolation and chemical properties of vitamins and their physiological action; and the distribution of vitamins in foods. The factors which tend to reduce the vitamin content of the diet are also discussed at length.

This compilation of lectures brings together a great deal of useful information and constitutes a handy reference book for investigators and students in nutrition.

C. F. LANGWORTHY

Catalogue of the Lepidoptera Phalænæ in the British Museum. Supplement. Vol. I. Catalogue of the Amatidæ and Arctiadæ (Nolinæ and Lithosianæ) in the collection of the British Museum. By SIR GEORGE F. HAMPSON, Bart. London. 1914. Pp. xxviii + 858.

In this large volume all the new species are treated that have been made known since the publication of Vol. I. (1898) and Vol. II. (1900) of this series of catalogues or, more properly, monographs. The family name Amatidæ is a change from Syntomidæ, formerly used, on the ground that the generic name *Amata* Fab. has priority over *Syntomis* Ochs. There are many synonymic references and corrections of generic locations all of which will be extremely useful as aids to identification of species. 330 genera and 2,002 species are referred to, of which 10 genera and 43 species represent new forms described from America. A separate volume of 41 colored plates accompanies the work.

HARRISON G. DYAR

SPECIAL ARTICLES

THE REARING OF DROSOPHILA AMPELOPHILA LOEW ON SOLID MEDIA

DURING the course of some experiments on *Drosophila* which one of us was performing, it became necessary to observe the beginning of oviposition. It is impossible to see the

eggs and difficult to see the larvæ in the mass of fermenting banana ordinarily used in rearing *Drosophila*. For this reason and for many others one can clearly see what the advantages of a transparent solid medium might be.

Banana agar was made as follows: Five or six bananas were mashed up in 500 c.c. of water. This was allowed to infuse on ice over night, after which the liquid was passed through cheesecloth. Powdered agar-agar was then added in the proportion of 1½ grams to 100 c.c. of the banana infusion. This was then heated until the agar had dissolved. The liquid was next filtered through a thin layer of absorbent cotton into test tubes. The tubes were then plugged, sterilized and slanted in the customary manner.

Media so prepared are quite transparent. Greater transparency may be obtained, of course, by repeated filtration, but this removes too much from the food value. The slanted tubes give about 6–7 c.c. of food with a feeding surface of about 15 sq. cm.

Adult *Drosophila* are inserted into the tubes. The tubes are then incubated at 35° C. or kept in some other warm place. In a day or two the small white eggs may be seen deposited everywhere on the surface of the agar. In a day or two more the eggs hatch and the small larvæ can be seen working in the medium. The average number of days required to complete the cycle on the agar from egg to adult is about thirteen. This is three days longer than the average number of days required on the ordinary fermenting banana mash. This means that the amount of available food is too low. That this is the case is further shown by the fact that some of the larvæ die prior to pupation, and that the flies are somewhat undersized. It is highly probable that the amount of food may be increased by the use of some concentrated form of food like banana flour. An increase of the feeding surface may likewise help.

We have also succeeded in rearing *Drosophila* on potato agar. The average number of days required to complete the life cycle is 15 on this medium. The flies are very much smaller than those reared on banana agar. Clearly, the amount of available food in the potato must be very small.

Of course, bacteria always develop on the medium and sometimes we are troubled by molds. The bacterial growth does not seem to harm the larvæ and the molds are usually destroyed by the larvæ just as soon as they hatch. Sometimes the fungus growth becomes too luxuriant between egg deposition and hatching. At such times the larvæ are killed by the growth, but this is exceptional. It is well to take all bacteriological precautions in handling the tubes.

The agar method for rearing *Drosophila* has the following advantages. The eggs "stand out" clearly and hence the time of deposition and hatching can be noted. The larvæ can also be clearly seen and their habits observed. By using various synthetic solid media, *Drosophila* may become the subject for interesting nutritional experiments. Our solid medium has the slight disadvantage that the concentration of the food is too low. This difficulty can probably be remedied by the addition of some concentrated form of food like banana flour.

J. P. Baumberger,
R. W. Glaser

Bussey Institution

THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The sixty-ninth meeting of the American Association for the Advancement of Science and affiliated national scientific societies was held in New York, December 26 to 30, under the presidency of Dr. Charles R. Van Hise.

Owing to the large number of organizations brought together at one time, and to the fact that many local institutions are intimately related to these organizations, the places of meeting were widely scattered. The general headquarters of the association were maintained in Earl Hall of Columbia University, and the various buildings of the university served very admirably for the meetings of many of the sections and affiliated societies. Others met at the American Museum of Natural History, at the College of the City of New

York, at the Cornell and other medical schools of the city, at the Engineers' Club and in a number of other places.

The formal opening of the meetings of the association took place on Tuesday evening, December 26, in the Auditorium of the American Museum of Natural History. The association was welcomed to the city by Fire Commissioner Robert Adamson, representing Mayor Mitchel. President Van Hise responded to this welcome on behalf of the association, and then introduced the retiring president, Dr. W. W. Campbell, who delivered an address upon the theme "The Nebulæ." The address was profusely illustrated by a magnificent series of lantern slides. Following the address, a reception was tendered to the members of the association by the honorary reception committee of the City of New York in the newly opened Hall of the Age of Man.

During the meetings the two addresses were given to which the citizens of New York were especially invited, and which occasioned especial interest. These were as follows: "Infantile Paralysis and the Public Health," by Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research. "Nitrogen and Preparedness," by Dr. Arthur A. Noyes, director of physical chemical research at the Massachusetts Institute of Technology.

There were a large number of addresses by retiring officers delivered before the various sections and societies and many of these attracted especial attention, since they touched in various ways upon the great question of national economy and conservation of national resources. A list of the addresses of retiring vice-presidents follows:

Section A. Armin O. Leuschner: "Derivation of Orbits—Theory and Practise."

Section B. E. Percival Lewis: "Recent Progress in Spectrography."

Section C. William McPherson: "Asymmetric Syntheses and their Bearing upon the Doctrine of Vitalism."

Section D. Bion J. Arnold: "The Interrelationship of Engineering and Pure Science."

Section G. W. A. Setchell: "Geographical Distribution of the Marine Algæ."

Section H. Lillien J. Martin: "Personality as revealed by the Content of Images."

Section I. George F. Kunz: "Scientific Efficiency and Industrial Museums our Safeguard in Peace and War."

Section L. Ellwood P. Cubberley: "Some Obstacles to Educational Progress."

Professor Vernon L. Kellogg, vice-president of Section F, sent a cablegram from England that imperative engagements in connection with his Red Cross work would prevent his attendance and the delivery of his address.

There was held at Columbia University a scientific exhibit and conversazione arranged by committees in each of seventeen sciences. There was also held at the American Museum a chemical exhibit and a Pasteur exhibit.

At the meetings of the council action was taken upon a number of matters of general interest to the members of the association. The two amendments to the constitution and by-laws proposed at the Columbus meeting were passed. The one of these designates section C as "chemistry." The other, amending Article 9, makes the secretaries of the sections eligible for reelection.

Two amendments were proposed which will be acted upon at the next meeting. First. Amend Article 9 as follows: Insert after the words "Permanent Secretary" in lines 5, 8 and 9, the words "General Secretary" (to make the term of office of the general secretary five years).

Second. In Article 35 for the words "three" substitute the word "four" so as to read "The annual dues for members and fellows shall be four dollars."

On recommendation of the committee on policy action was taken in the following matters:

1. A committee of seven on grants for research was constituted to apply the research income of the association, the committee to be appointed by the president.

2. It was decided that in the case of members of affiliated societies, elected to membership in the American Association for the Advancement of Science within one year of the election to membership in an affiliated society, the entrance fee shall be remitted.

3. The council authorized the appointment of a committee of twelve fellows resident in Washington and representing each section of the association to scrutinize the list of members and to nominate fellows to the council.

4. The council endorses the following resolution: "Resolved that the American Association for the Advancement of Science advocates the greater use of the metric units of weight and measure in the United States so as to increase the usefulness of our publications and to aid our foreign relations with the many countries where these units are official and in use."

5. The council approved the selection of Dr. Henry M. Howe as vice-president of Section D to succeed the late Dr. E. L. Corthell, and of Dr. C.

Stuart Gager, as vice-president of Section G, to succeed the late Dr. Thomas J. Burrill.

6. On recommendations of the committee on policy, this same committee was instructed to prepare a revision of the constitution of the association, with by-laws, and to report to the council at its next stated meeting. As a part of its recommendation the committee on policy asked that the council should instruct the committee in this revision especially to redefine the duties of the permanent secretary and of the general secretary and the council acted favorably upon this request.

7. It was voted that $4,000 or whatever sum is available from interest on the permanent fund, be appropriated to the committee on grants for allotment, and that the treasurer be directed to pay the sums allotted on the order of the chairman of the committee. The committee on grants, appointed by the chair with the advice of the committee on policy, consists of E. C. Pickering, chairman; W. B. Cannon, Henry Crew, N. L. Britton, E. C. Franklin, J. McKeen Cattell, secretary, leaving one vacancy to be filled by a geologist.

8. An appropriation for the coming year to the Pacific Branch of the association, of the entrance fees collected by the branch and $1 for each actual member, was made.

9. The permanent secretary was authorized to pay the expenses of local branches during the coming year in an amount not to exceed 50 per cent. of the dues from such branches over and above the expenses of the journals and also the entrance fees secured through the efforts of such branches.

10. The following resolution was also adopted: "On behalf of the American Association for the Advancement of Science, its council extends to the secretaries and bureau chiefs of the United States government its appreciation of the fact that through their encouragement the important scientific work under their directions has been well represented at the meetings of the association." This representation has greatly promoted the influence and usefulness of the bureaus, both by making their work more widely known, and by the stimulus imparted to and gained from other workers in similar fields. The association is so keenly interested in the work of the government bureaus that it ventures to express the hope that members of their staffs who are engaged in research be given all practicable encouragement to attend the meetings of the association and other national and international organizations devoted to the advancement of science.

11. The council took especial pleasure in gratefully acknowledging the receipt of the following gifts: From Mr. E. D. Adams, $1,000; from Mr. Cleveland D. Dodge, $500. Mr. Adams was elected a patron of the association and the two gifts were added to the permanent fund reserved for research.

12. At the meeting the following life members *emeritus* were elected: Cyrus Fay Paine, W. J. Beal, F. W. Clarke, W. H. Dall. Mr. Paine was elected a member of the association in 1858, and is the oldest member in continuous membership.

Franz Boas, H. L. Fairchild and Irving Fisher were elected members of the council for a term of three years: W. J. Humphreys, D. T. MacDougal and E. L. Nichols were elected to the committee on policy for a term of three years.

The seventieth meeting of the association and of the national affiliated societies will be held at Pittsburgh, beginning on Friday, December 28, 1917. Boston is recommended as the place of meeting in 1918.

Officers were elected as follows:

President: Theodore W. Richards, Harvard University.

Vice-presidents:

Section B: W. J. Humphreys, U. S. Weather Bureau.

Section C: W. A. Noyes, University of Illinois.

Section E: George H. Perkins, University of Vermont.

Section F: Herbert Osborn, Ohio State University.

Section G: Burton E. Livingston, Johns Hopkins University.

Section H: Edward B. Titchener, Cornell University.

Section I: George W. Perkins, New York City.

Section K: C.-E. A. Winslow, Yale University.

Section L: E. F. Buchner, Johns Hopkins University.

Section M: H. J. Waters, University of Kansas.

Secretary of Council: Walter V. Bingham, University of Pittsburgh.

General Secretary: J. McKeen Cattell, Columbia University.

Secretaries of Sections:

Section B: G. W. Stewart, State University of Iowa.

Section C: James Kendall, Columbia University.

Section E: Rollin T. Chamberlin, University of Chicago.

Section K: A. J. Goldfarb, College of the City of New York.

W. E. HENDERSON,
General Secretary

SCIENCE

FRIDAY, JANUARY 12, 1917

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SPECIALIZATION AND RESEARCH IN THE MEDICAL SCIENCES[1]

MODERN scientists are not encouraged and are become less inclined, except in the afterglow of an active life, to indulge in metaphysics. The visualization of material phenomena, particularly when set in motion by deliberate experiment and observed in their successive stages, tends to replace speculation as to a more complete, though less verifiable series of facts. This reliance in the natural sciences on observation and experiment rather than on ratiocination is responsible for the great and rapidly increasing body of useful knowledge we possess.

Philosophical treatises by even conspicuous representatives of the natural sciences have seemed to me to differ from those of the metaphysicians in that the former apparently fail to appreciate that the metaphysical game is played subject to certain rules which have the same purpose of order as the rules in other games. Philosophy is apparently a subject like fine arts, about which many people think they have intuitional knowledge. We judge pictures as bad or good not on the basis of certain criteria that have come through the ages to be recognized as essential, but in accordance with whether we like or dislike them. In the same way we may think, because we have a certain facility in the exposition of scientific data, that we can offhand write

[1] Address of the vice-president and chairman of Section K, American Association for the Advancement of Science, New York meeting, December 29, 1916.

an explanation of the larger relations in as direct and convincing a manner as William James did his "Pragmatism." As example of attempts of this sort, I am thinking of books like Haeckel's "Riddle of the Universe," and Shaler's "The Individual." Metchnikoff in his "Studies in Human Nature" would seem an exceptional biologist who has taken the pains to learn the metaphysical rules, and it is an interesting proof of the modern discouragement of speculation on the part of scientists to be credibly informed that the publication of this book sufficed to debar its author from election to honorary membership in one of our most exclusive national societies. This discouragement reflects what I believe to be a fundamentally incorrect attitude in many of us toward metaphysics. We regard it largely through ignorance of its methods, and lack of appreciation of its heuristic value, as a grab bag into which are dumped all conceptions that can not be demonstrated, or as a method adopted from unworthy motives by the scientifically inaccurate.

So much in explanation of an attempt as an alien to speak a language with which I am not familiar, the expressiveness of which, however, I venture to think I appreciate. So much in extenuation of an attempted exposition of one phase of scientific method. The thesis of my remarks is that the best method of accomplishment in the medical sciences is to adopt the bloodhound method of nose to trail, to encourage ourselves in specialization and still more specialization, to dig deep rather than to spread smooth.

My traveling acquaintance, a lawyer, could not understand, when we passed the power dam skilfully blocking the mountain torrent, why I could not explain to him the essential principle of converting the energy of the foaming water into electrical voltage. "I thought you were a scientist," he remarked scornfully, "That is a scientific problem, isn't it?" I had no crushing retort ready for him, but I hope I may at a later day explain and perhaps justify my more or less deliberate ignorance to you, a more discerning audience. The public expect results, but usually misunderstand methods of obtaining them; they are willing to accept the greater returns following greater specialization, but do not always realize that effective specialization takes even more time than generalization, and to some extent excludes it.

I imagine that many of us, if we were to present an ideal system of intellectual self-development in graphic form, would sketch a pyramid with a broad base of knowledge representing the lower educational years, sloping and narrowing upward toward the increasing specialization of a life work. It is inevitable that each additional unit of knowledge, each brick in the structure we are raising, will eventually take its place in some definite relation to every previous brick in the mental edifice by which we represent to ourselves the external world. But is this ultimate structure the one we should have in mind in training ourselves as brickmakers? Do we not confuse this edifice, toward which we may contribute a unit, with the plan by which we develop as contributors? The pyramid is a not unpleasing and certainly an enduring structure; it met admirably the needs of a tomb for Egyptian kings; it may serve as a dignified mausoleum for acquired facts, but the more rapid acquisition or reception of new facts may be better served by an essentially different construction. Certain more modern needs are better met, according to Signor Marconi, by a very thin and lofty antenna. May it not be that the wireless outfit resting on no considerable base, though carefully supported by connecting

strands, typifies the modern method of development of one's powers for productive scientific work? Does not this delicate apparatus, shooting up straight from the earth, allow expansion into the unknown which the self-limiting convergence of the planes of the pyramid excludes?

At all events, it is no longer possible for one to master all, or even several contributory sciences, before turning his attention in a productive way to one of them; there is not time or strength enough. We are no longer in the middle ages, where a genius like Dante could reflect all knowledge that had preceded him in a set of scholastic and poetical treatises, or another like Leonardo da Vinci could contribute to several arts and sciences methods that were fundamental. I appreciate, I believe, the surprising vigor of Leonardo's intellect, but am not willing to admit that his astonishingly successful versatility proves him a type of superman that has ceased to exist. I feel sure that Leonardo's intellectual equal may well be among us to-day, but could never by any chance make notable contributions to subjects so diverse as painting, sculpture, engineering and mathematics. This would seem to prove not that the race of man has fallen off, but that each of the subjects has so grown in complexity as to require a lifetime to master. It is no little factor in success in any subject to be early in the field, to be the first explorer. In many respects it requires greater powers of observation to detect further important details in a landscape, the important and perhaps more obvious features of which have already been described by another. The earlier observer, moreover, has the undoubted advantage of entering on his work with a mind untrammeled by the notions of numerous predecessors.

The most modern equipment for scientific advance need be burdened with no very heavy impedimenta of fact—the newer science develops or rediscovers the methods of other sciences at need without having mastered their content in fact. To justify this light-marching order, which I venture to recommend for the scientist in his invasion of the unknown, I must outline my conception of the nature of scientific progress and then discuss to what extent each science is dependent on other sciences in this advance. Let me repeat that I have in mind primarily the newer biological sciences, particularly those that relate to medicine, and am considering them in relation to one another and to the more fundamental sciences of mathematics, physics and chemistry. My remarks doubtless do not now apply to these latter fundamental groups which seemed to have developed into a more closely correlated and perfect whole where interdependence seems more constant. Am I not correct in assuming that in its early development, chemistry, for example, was less dependent on mathematics and physics than it is to-day? May we not look upon these three sciences as similar in their growth to three adjacent trees which at first stood clear from each other, but which in their further development have intertwined their branches and roots so that they now appear from a distance as more nearly an entity?

At all events progress in the biological sciences depends, first, on discovery of new facts by purely observational and by experimental methods, and, secondly, on the elaboration of hypotheses and theories as a means of uniting these data and as introductory to more facts. Let us consider in some detail the method by which each of these advances is made and in what respect knowledge of kindred sciences is essential in this analysis and synthesis.

It seems obvious to us now that proper appreciation of any scientific phenomenon

must depend first on a knowledge of its component parts and their functions. This analysis or dissection not only must precede, but seems at once more intimately scientific than the synthetic stage that follows. I here use the word "scientific" in the specialized sense of acquiring data concerning natural phenomena. The second or synthetic stage is more metaphysical in that it considers data that have been acquired in their relation to one another. The first phase is more intimately scientific, then, in that we are actually in contact with those elements which we describe as facts. The second or synthetic stage is, however, fully as essential to progress in that *without* it we should never pass from a known group of facts to one that is unknown. The synthesis of small or less certain groups of facts gives rise to the working hypothesis which, in its proving or disproving, leads to other facts. Larger or more certain groupings of fact constitute a theory which, in its restatement of evidence, serves as a point of departure for further advance. A theory may stand for an indefinite period as a complete statement of the facts with which it deals, or it may soon be supplanted by a better one. In either case it has its heuristic value.

In eliciting facts certain methods are required, in the larger sense methods of discovery, in a more restricted sense methods of technical precision. It might be thought that in methods of discovery, certainly, a knowledge of the methods of other sciences would be essential, and so indeed they are, but in no exclusive sense. It has never ceased to surprise me to find from conversations with my colleagues in other branches that all experienced investigators employ the *same* methods of discovery—the materials we handle may be as diverse as you like, the technical details incomprehensible to one another, and yet the methods of attack on the unknown remain the same. We all gravitate through experience into the same channels of reasoning, the same methods of planning experiments, of erecting working hypotheses, of rejecting them when they fail of verification, or of trying them further when they pass the first test satisfactorily.

There remain, then, methods of technical precision. For the purpose of this discussion of the usefulness to the biological medical sciences of more fundamental or of merely contributory sciences, we may consider methods of technical precision as statistical, instrumental or experimental. No claim is made as to the inclusiveness of this cataloguing.

There is some dispute, I believe, as to whether statistics constitute a separate science or merely a method. At all events, statistics are used as a method in all sciences or groupings of fact. Of late, statistics are used to a large extent in certain biological work, notably in the branch of hygiene dealing with vital statistics, and in certain more theoretical branches as the laws of heredity (Mendelism). It is obvious that any science which in its analytic phase accumulates a mass of figures or data will need statistical methods. I am not aware that statistical methods can be learned apart from the constituent facts which they are aimed to elucidate. It seems to me that such methods are best learned by using them, and that there is no particular object in learning the use of statistical methods in reference to wages, let us say, for the purpose of applying them in investigations of the incidence of tuberculosis. In either case we must refer to treatises written by those who have used statistics extensively both for the general methods and causes of error involved in their use. Statistics, to repeat, is not a separate science, but a

method employed at need, and a part of any science that uses them.

We have next the use of methods of precision. This may imply the use of a piece of apparatus, or a reaction that has been of service in another science. The use of such a piece of apparatus may suggest itself synonymously with the needs which it was intended to meet. Thus, if in one of our biological products we have reason to wish to measure total nitrogen or amino nitrogen, we should undoubtedly turn to a chemist who would suggest the Kjeldahl or the Van Slyke methods. The reference suggests at once what I should regard as the best method of reapplying the methods of one science to another science, namely, collaboration, or intimate contact with specialists in various branches. The man who thinks he is trained in one science by having passed through it a few years before, may well fall into the error of using methods he has learned rather than better methods since discovered and currently employed by specialists. A personal example may illustrate this fact. A few years ago one of my associates and I were working on a problem which finally required a chemical estimation of the amount of glycogen in the liver. This determination necessitates the rapid reduction of glycogen to glucose, followed by its quantitative estimation from the amount of copper oxide reduced. Fehling's technique had been the classical method followed in such estimations. Not trusting to our own judgment as to superiority of this method, we consulted a graduate student in the department of biochemistry who was working constantly with glucose determinations of this sort, and, following his advice, adopted the modification of Fehling's method which had recently been made by Bertrand. A few months later, on visiting a large eastern hospital where determinations of the amount of glucose in the blood were being carried out, I learned that six months' data had just been discarded, owing to the fact that the physician who was conducting the experiments had trusted his rather unusual training in biochemistry and had overlooked Bertrand's important modification, which he later adopted and which we employed throughout our study, owing to the fact that we had deferred to the opinion of a specialist.

It is doubtful if methods of experimentation, purely speaking, can be carried over from one science to another. We have stated that the methods of discovery in the broader sense are the same in all sciences, however different the component factors may be. In methods of experimentation, however, variation in factors counts. I have constantly been struck with the fact that the chemist experiments in a manner that is essentially different from the one which my work demands. Chemistry is a far more exact science than experimental pathology in the sense that the factors with which chemistry deals are better known. It is interesting to note, however, that a chemist may, and frequently does, accept certain biological evidence as proved which we should reject as inconclusive, owing to the omission of certain controls or checks. This difference in viewpoint is dependent on the failure of the chemist to appreciate certain fluctuations in living material which it is impossible now and will perhaps to some extent ever remain impossible to determine at a given moment. It does not suffice, moreover, to determine the mean of such a variation in a great number of instances, for the purpose of obviating controls in a given experiment.

In dealing with the interactions of two substances in chemistry we have to begin with, under the simpler and usual condi-

tions, union in fixed and in multiple proportions. It is true that in reactions between a weak acid and a weak base there is union in variable proportions, so that a series of compounds are formed. But in general it may be said that in chemical reactions the results may be foretold when the effect of controllable factors such as dosage, temperature, atmospheric pressure and the like, have been determined. The substance concerned in the reaction, and the conditions that affect it, have been rigorously tested and are understood, so that a given result can always be counted on. The experiment controls itself when properly performed. On the other hand, no one can tell what will happen if he injects a million staphylococci into the ear vein of a rabbit. The animal may be dead the next day with no evident lesions; it may die a week later with abscesses in various parts of the body, or it may show no symptoms and recover perfectly. These disparate results are due to the fact that in an experiment of this sort we are confronted with two sets of variable conditions inherent on the one hand in the living microorganism that is injected and on the other in the experimental animal. We recognize the existence and to some extent the range of certain of these variables, but remain ignorant of many of them; the majority of them are inherent in the condition we designate as life and disappear in death. It is incorrect to assert that our ignorance of them is due to an interest in vitalism. We are free to admit that our science is very young, that our data are relatively few, and that our ignorance of the factors concerned is great. And yet we have a group of significant, reliable and practical phenomena that we can reproduce at will when we handle these variable factors in our own way. Many of our reactions, although indefinite from the standpoint of chemistry, are of a delicacy that chemistry rarely, if ever, attains. The point of interest here is that the experimental methods of present-day chemistry not only have not led us to new facts in our field, but do not help us much to explain or control our present ones. In the experiment cited we can not assert from previous experience exactly with what point in the range of either variable factor we are confronted, we can not previously determine our conditions and know that they now actually exist. We know in a general way that in the experiment I have outlined we have to deal particularly with fluctuations in the virulence or pathogenicity of the staphylococcus concerned and with variations in the resistance to infection in the individual rabbit. Our type of experiment, then, is never complete unless we introduce numerous simultaneous and external controls. In the particular problem I have cited, we find that although one million staphylococci killed Rabbit No. 1 yesterday, a subsequent transplantation of the microorganism fails, in the same dose, to kill Rabbit No. 2 to-day. It could be determined that this result is due to a loss of virulence in the microorganism by the introduction of Rabbit No. 3 which is given twice the dose and dies as did No. 1 yesterday. Individual variations in resistance may, to a great extent, be avoided by choosing for the experiment rabbits of the same weight, raised under the same conditions, or, better still, from the same litter.

As a further illustration of the difference in viewpoint between the chemist and ourselves, let me suggest that the tendency of the former on entering our field of activity would be to devise a more precise method of estimating the number of bacteria used in the experiment rather than to introduce such controls as I have mentioned.

The problem I have given you is one of the simplest with which we have to deal. Conceive of the far greater complexity if we introduce an immune serum against the staphylococcus in such an experiment designed to increase the resistance of the rabbit to which it is given, and you will imagine where the real complexity of our science begins. Such a serum differs in its potency with the individual animal that has produced it, with its age after withdrawal from the animal body, and with the method by which it has been conserved; in other words, it introduces another variable factor. I may again define our mode of experimentation as differing from that of chemistry in requiring the introduction of simultaneous, external controls, the object of such controls being simply to define the effect of those conditions which we recognize as contributing to a given result.

Such differences as these, then, lead me to think that even great experience in one type of experiment will not fit one directly for experimentation of another sort. I do not mean to intimate that training in methods of precision is not of value, however different the conditions may be, but the best training for a given end lies in work and more work with the intrinsic materials involved, not so much as leading to greater technical accuracy as tending towards the establishment of an essentially specialized experimental viewpoint.

We come now to mention the value of multiple scientific experiences as fitting one for the larger synthesis or generalization in a given science. I have not reached that age where such generalizations as I mean appeal to me as the more important field in the experimental sciences, although I recognize that they are eventually necessary to present our work as a whole and in its practical aspects to the world at large. Such generalizations do, of course, imply factual knowledge of the wider sort, and I must confess to being awed at times by the aptness of apparent analogies between the better-known conditions which exist in one science in explaining formative theories in another science. Personally, I also usually doubt the rigorous exactness of the conclusions drawn in respect to the significance of any one science by one who handles freely the data of several sciences. I suspect at once the reportorial viewpoint, the existence of second or third hand, and ever so slightly garbled information. I am inclined to trust the solution of my problems to a combination of specialists rather than to the superman. Here again I plead for collaboration.

In our great, vital and complex science of medicine we can see, I think, an illustration of the ultimate value of intensive specialization and of deliberate or chance collaboration. Out of indefinite, speculative, empirical, bedside methods of the practitioner, have emerged, through the stimulus of the exact sciences, a growing number of increasingly accurate and effective laboratory branches. These laboratory sciences have become of practical value in the diagnosis, prevention and cure of disease, precisely as they have become separate entities and have fallen into the hands of whole-souled and intensive specialists. I make no mention here of the intellectually satisfying value of a concrete body of similar facts which constitutes a science. The relatively rapid applicability of the data of laboratory medicine to human welfare is at once an enormous stimulus to accomplishment and also a potential danger, owing to the possibility of too rapid generalization and application to meet a practical need. There are many who are impatiently waiting with individual needs in mind to apply any method of apparent value we may devise, and it

requires at times no little self-restraint to withhold an apparent innovation for greater certainty. Over-enthusiasm greets the advent of every fact that has the least suggestion of practical value. We have ourselves lived through successive eras in medical progress when from each group of specialists was expected the last unraveling of the human mystery. Morphologist, physiologist, bacteriologist, and biochemist has each had his turn. The ultimate truth lies in all these sciences, and again in no one of them alone. The danger to sober advance is not in the successive enthusiasms with which each specialty has been received, but in the dabbling methods of a group of investigators who have attempted to "follow the ball"; investigating a given medical problem in successive years by the latest method in vogue, becoming rapidly in turn pathologist, physiologist, chemist.

The ultimate solution of each medical problem lies in the combined attack of a group of investigators converging from different points of the scientific compass, each trained in a separate method and employing it intensively. The problem of cancer, for example, is now being studied by the morphologist who describes hitherto undifferentiated structures in the malignant cell by special staining methods; by the immunologist who demonstrates the presence of reaction bodies in the serum of cancerous animals and human beings; by the chemist who shows that certain substances given parenterally inhibit or stimulate cell growth, or who produces similar results by the use of various diets; and by the expert in vital statistics who shows the actual increase or decrease in incidence of the disease by the biologist who shows in Mendelian tables the heredity of the disease in animals; or, again, the effect of cross-breeding on transmission of the tumor; and by the physicist who demonstrates the effect on the tumor growth of X-rays or radium. I have not exhausted the category, but merely wish to indicate that the significant advances in each of these methods of approach are made by specialists. Do not misunderstand me to mean that any one of these investigators may not be led by his work to assume seriously and purposefully the activities of any other type. Pasteur was a chemist who became a biologist and probably the greatest contributor to medicine, although without medical training, because he followed his problem to the bitter end into whatever field it led, with little regard for the fact that he was, technically speaking, unfit to encroach on medical territory. He rediscovered medicine from a new angle, untrammeled by any preconceived notions of how disease was regarded. Ignorance of veterinary medicine did not prevent him from isolating the causative agent of anthrax in cattle and from utilizing an attenuated virus in its prevention. Failure to have studied the central nervous system of man was no obstacle to the man who discovered the essential cause of hydrophobia and the means of preventing it. Imagine insisting that Pasteur's curriculum should have included medicine as a necessary prerequisite to the discovery of the fundamental principles of the infectious diseases.

I hope you will not take my remarks as indicating anything but the highest appreciation of instruction in the sciences in general as the best training for the youthful mind, or as contributive to general culture. You will not accuse me of advocating early vocational training without a preliminary survey of the realm of knowledge. To be specific, you will not imagine that I discredit the now universal requirements that premedical students should acquire a modicum of chemistry, of physics, and of

biology as furnishing an intelligent, scientific viewpoint for their subsequent study of medicine. Such a survey is not only good, but very properly prescribed as necessary. My remarks have been directed at a very different level and type of intellectual development from this; we have been considering our own particular problems as investigators. What I have been interested in discrediting is the persistence of ideas of machine-made education into the productive years of scientific life; the idea that if we seek eventually to become effective we should take care to perfect ourselves laboriously in each of the branches that have been regarded as fundamental. There is a real danger that we may spend our lives preparing ourselves for an indefinite piece of work that we never even start. It is, of course, much easier to continue preparing ourselves, to keep our scientific judgment strictly symmetrical by endeavoring to fit in each contribution that *others* make into its proper place, rather than to insist that one particular piece of work must be done *now* and to the exclusion of everything else. This insistence, however, I consider to be the true raison d'être of specialization, the only basis of real productivity.

These remarks, to repeat, are not a recommendation for educational anarchy, but an explanation of how a somewhat one-sided development may not only not be inconsistent with, but indeed the very essence of highest accomplishment. This is not so much a recommended program as an explanation of how things really work out. It is intended to some extent as helping to dispel the discouragement that I believe has come to many of us when we cease to be mere recipients of information and in a position to think and to do for ourselves in a chosen profession. I must confess to many hours of doubt for more years than I care to admit, as to whether I should really accomplish *anything*, owing to the fact that I had failed to become a good chemist *en passant*. It was always and increasingly too late to turn back and repair the errors or omissions of education, and as my problems finally gripped me instead of merely inviting me, I silently gave up the struggle to remodel my life. And in following some of these problems in certain of their ramifications, I found that although I could never hope to learn chemistry, I was curiously enough collaborating in investigations that utilized that very type of chemistry which my work required. I was absorbing in this intimate way certain very restricted forms of chemistry in the making.

Out of such experience has gradually formed a certain working philosophy, or, better, a philosophy of work which I have tried here to present to you. Those of you with less limitations may well question much that I have said, you may assert that breadth does not of necessity mean superficiality, and per contra, that digging a hole does not necessarily mean that it is deep, but in certain respects I am sure you will agree with me. Specialization in science, even in the narrowest sense, is essential to real accomplishment. Any extension of knowledge is dependent on an attentive consideration of a relatively small group of facts to the temporary exclusion of less related facts. To a great extent the smaller the group the greater the concentration possible, and the greater the resultant accomplishment. Each science is independent in so far as the individual investigator is concerned, and correlatively all sciences can be learned with each specific scientific problem as a point of departure, at least so far as the needs of that problem demand. On the solution of problems depends the future of science.

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RESEARCH IN INDUSTRIAL LABORATORIES[1]

At the second meeting of the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science, on December 28, 1914, the subcommittee on research in industrial laboratories was constituted to consist of Drs. R. F. Bacon (chairman), C. E. K. Mees, M. C. Whitaker, W. R. Whitney and W. H. Walker.

The following problems in the direction of industrial research have been considered by the subcommittee:

1. The organization of industrial research.
2. The selection and training of students for industrial research.
3. The factors involved in the promotion of cooperation between manufacturers and the universities, with particular attention to the depreciation of the policy of industrial secrecy.
4. The promotion of a better appreciation of research, with particular regard to the education of the public to the realizable functions of industrial research.
5. The establishment of stable relations between research institutions and the research departments of industrial plants.
6. Finally, the advisability of conducting a comparative study of the investigational activities, capacities and facilities of organizations devoted to or carrying on industrial research.

The conclusions arrived at by the subcommittee are presented in summary in the following report.

THE ORGANIZATION OF INDUSTRIAL RESEARCH

Principles involved in the organization of industrial scientific research have been discussed at length during the past year by Dr. C. E. K. Mees, a member of this subcommittee, in SCIENCE, N. S., *43*, 763. The chairman of the subcommittee has also considered some principles in the administration of endowed industrial research laboratories in the *Journal of the Society of Chemical Industry, 35* (1916), No. 1.

It is generally conceded by those engaged in the direction of industrial research that, in order to be efficient, research laboratories of this type should be as thoroughly equipped as possible. In the case of industrial concerns having a number of plants and in the case of organizations of manufacturers, the tendency of organization should undoubtedly be towards concentration and cooperation in the maintenance of one large well-equipped research laboratory, rather than towards the erection and support of a number of smaller separated laboratories. It is, of course, necessary, especially in the case of chemical plants, that the analytical and control work be carried out *in situ,* but experience indicates that it is much better practise to centralize the research work.

Since the policy which insures adequate guidance to a research organization must be based upon the accumulation of facts, method in laboratory administration should provide for facilities for securing detailed information on a vast field, and for competent counsel from those who have a store of specialized knowledge. When the laboratory executive's work has passed the one-man stage, a division of labor comes about and it is here that he must see to it that he surrounds himself with men who are capable of effective effort—alert, original investigators of initiative and leadership.

An organized research administrative staff should not only result in effective division of labor, but also in efficient expenditure of executive energy, more effective plans, and general stabilization. This can come about if there is a pervading organization type of mind, which "is common to those drilled in systematic thinking and long immersed in the materials of their particular vocation. Such a mind sees details, but only as parts of a whole; reaches generalizations, but by the inductive route."

With regard to the investigatory staff, while the individual can exert only a very small influence except as a member of an organization or institution, yet a research institution never gains note or influence except through the

[1] Report of the Subcommittee on Research in Industrial Laboratories, presented by the chairman, Dr. Raymond F. Bacon, at the meeting of the Committee of One Hundred on Scientific Research, New York, December 26, 1916.

attainments and achievements of its individual members. The research department of a large industrial concern will be great because it has investigators on its staff who possess great originality and ability and because its director is wise and far-sighted. It is generally conceded that the personal factor is always paramount in industrial research, and that, as in every other organization, the control of men is the real problem in laboratory administration.

A brief consideration of the conditions favorable to both pure and industrial research is pertinent in connection with any discussion of the personal organization.

It is particularly adverse to progress to regard able investigators as abnormal men; for successful research demands neither any peculiar conformity nor any peculiar deformity of mind, but it requires, rather, peculiar normality and unusual industry and patience. It is little less inimical to expect productive work from those who are absorbingly preoccupied with other affairs than research; for fruitful scientific inquiry entails, in general, prolonged and arduous, if not exhausting, labor, for which all of the researcher's time is none too much. This is the experience of the Carnegie Institution and all other research organizations. It is only to be expected, therefore, that those most likely to produce important results in research are those who have qualified for the responsibilities thereof by the completion and publication of several worthy investigations, and who are at the same time able to devote the bulk of their energies thereto. The productive researchers in our universities are those who are devoting their whole time, or practically their whole time, to investigatory work.[2]

Research should never be allowed to fall into the rut of prosaic routine. The personnel of the investigatory staff should be maintained at the very highest standard and all administrative plans should be carried out with enthusiasm and earnestness.

In the research laboratories of manufacturing plants the personal cooperation of the research staff with the members of other branches of the organization always proves an important aid in maintaining interest in the work and is, in addition, mutually educating.[3] In particular, the research department should have an *esprit de corps* that keeps things moving and should lead the way so strikingly as to be apparent to all other departments of the corporation. In consequence, mediocrity should never be tolerated. It should be borne in mind, however, that the research man can only accomplish efficient work when he is free from restraint and petty annoyances.

Cooperation is always contributory to success in a research laboratory, and, other conditions being equal, the valuable men are the ones who can and will cooperate with one another. As in business, men succeed only as they utilize the ideas and services of other men. It follows, therefore, that the strength of an investigatory staff, properly operated, should increase more rapidly than the increase of its numbers, and that a fraternal spirit will play an important rôle in the productiveness of any research department.

The experience in several of our most successful industrial research laboratories has clearly shown that cooperation between the different departments thereof can be adequately and completely obtained by well-planned weekly conferences on the subjects under study. While some directors of industrial research hesitate to spend the time which these conferences entail, it is the opinion of the subcommittee that conferences of this na-

[2] As a rule, the head professors of chemistry in the larger universities are not giving more than three to five hours of lectures during the week, the rest of their time being devoted to research, while a number of them have one or more private research assistants, besides the candidates for advanced degrees, doing research work.

[3] In several of our largest corporations, the plant superintendents make monthly reports to the research departments, including all ideas of their own or of their assistants which may in any way warrant investigation. Then, too, the salesmen report regularly to the research department regarding the various ways in which the company's products are used and what substitutes are employed for the company's products. Such plans stimulate closer thought and observation.

ture are worth far more than the time they take.

THE SELECTION AND TRAINING OF STUDENTS FOR INDUSTRIAL RESEARCH

Research leading to the discovery of new ideas requires not only intellect and training, but also initiative or genius; it can come only from an individual who possesses unusual intuition and insight. It follows, therefore, that there is a scarcity of men gifted with the genius for industrial research and that it requires much experience in selecting suitable men and in training them to the desirable degree of efficiency, after having determined the particular qualities required.

The important requisites for industrial research are often unconsidered by manufacturers, who, in endeavoring to select a research chemist, are likely to regard every chemist as a qualified scientific scout. The supply of men capable of working at high efficiency as investigators is well below the demand; and chemists having the requisites and spirit of the researcher are indeed difficult to find even by those experienced in the direction of research. All research professors know that the location of a skilled private assistant—one who possesses not only originality, but also sound judgment and intellectual honesty—is not easy, because it frequently involves the gift of prophecy on the part of the searcher.[4] It has been truly said that the "seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them."

On account of the extraordinary importance of new ideas, particular emphasis should always be laid upon finding and supporting brilliant researchers. Such individuals can best be found in the universities. The function of the university is to work with the beneficent idea of increasing the sum of human knowledge, and among its most valuable products are those who will work for the exercise of the investigative instinct and the pleasure of overcoming difficulties.

[4] See discussion in SCIENCE, N. S., 41 (1915),

The examination of the training necessary for those proposing to take up industrial research which is common with all scientifically trained men, is too extensive a subject to be discussed by the subcommittee at this time. It is, however, appropriate to consider those subjects in which it seems desirable for the prospective researcher to specialize: reference is, of course, had to subjects other than those required by the average student of the sciences as distinguished from their industrial application, but the assumption is not made that what is desirable for research work should not also be available for all.

Research men frequently possess adequate training and scientific acumen, but fail in their ability to use it. There is no question that the element most noticeably lacking in the modern graduate is *resourcefulness*. A qualified research chemist who possesses initiative is usually a creator; but owing to the neglect of existing difficulties in chemical pedagogy, the present-day graduates of our schools of chemistry are too often deficient in inspiration, ingenuity and insight.

The failure to provide adequate and systematic instruction in chemical literature is illustrative of this contention.

Before commencing laboratory work upon any problem, it is obviously necessary to digest intelligently the important contributions which have been made upon the subject and to take advantage of what other workers have done in the same field. The average graduate is usually almost helpless when attempting to do this and consequently requires close supervision. The main difficulties are:

(*a*) He does not know how to go about it; he does not know where to look as the most probable source; and he is not familiar with the standard treatises and important journals.

(*b*) He fails to analyze the subject into its factors and hence generally looks for topics which are too general. Because he does not find any reference to the problem as a whole as he has it in mind, he assumes that nothing has been done upon it and that there is nothing in the literature which will be of aid to him in the investigation. Were he to sepa-

rate his subject into its essential parts and then to consult the literature on each factor, he would find considerable information which he otherwise would miss.

(c) He does not critically digest the articles under examination, but often he makes only a few disconnected quotations and fails to interpret the work done.

The solution is to be found in the provision in the chemical curriculum, preferably in the senior year, of a course of lectures on the literature of chemistry, with particular reference to the character of the writings and the status of the authors. The purpose of these lectures should be to present a general survey of the voluminous literature and to impart an accurate, systematic working knowledge of chemical bibliography. A concurrent seminar should be devoted to indexing and tracing chemical literature, to the cultivation of an acquaintanceship with authorities, and to the solution of bibliographic problems.

The subcommittee also recommends that pedagogic attention be given to the arrangement of a course of study in the principles of technical reporting and in the criteria of literary excellence in the preparation of reports of researches and professional reports. The completion of such a subject, with its accompanying analysis, practise and criticism, would usefully supplement the training received in chemical bibliography and would develop a capability which is much needed by chemical graduates.

It may be noted in passing that, during the academic year 1914–15, distinct courses in chemical literature and in technical reporting were established at the University of Pittsburgh. Much success has attended this pedagogic innovation.

The chemical graduate of to-day is also deplorably deficient in resourcefulness in planning research. While this is an extensive subject, a research student may be trained in correct methods of attack, namely:

(a) *Analytical Methods*.—Almost all investigations require analytical control. In no feature of chemical work is there more apparent an inability to use the analytical training which the man has received.

(b) *Planning the Investigation*.—Resourcefulness in separating a problem into its essential factors and in clearly grasping the interrelationship of these factors is most important. Too many men desire to start in at once and solve the problem at the first attempt. All this might be summed up in the expression "methods of research."

(c) *Apparatus*.—The subcommittee has not considered just how a man could be trained to be more resourceful in this respect, but it is surely a marked weakness in the average graduate. While a native cleverness is doubtless born, and not made, it ought to be possible to give the undergraduate some training in the use of his mental equipment in designing and planning apparatus which is to accomplish the desired end.

THE FACTORS INVOLVED IN THE PROMOTION OF COOPERATION BETWEEN MANUFACTURERS AND THE UNIVERSITIES[5]

The recent impetus imparted to the research activities in American chemical manufacturing has materially altered the traditional policy of industrial secrecy. A striking illustration of this improvement is to be found in the reports of the Industrial Conferences held at the fifty-third meeting of the American Chemical Society.[6] This change in attitude, a natural result of the appreciation of urgent action in industrial research, has long been desired by our universities and it will undoubtedly result in the extension of the practise of referring certain of the problems of industry to university laboratories for study. Many of the numerous problems of chemical as well as mechanical technology could be advantageously attacked outside of the plants, but some central organization is needed for securing and properly distributing those problems which are pressing. It is clear, however, that stable

[5] The president of the American Chemical Society has been authorized to appoint a central committee from representatives of the universities and the industries to study opportunities and to make recommendations for cooperation.

[6] See *J. Ind. Eng. Chem.*, 8 (1916), 947 *et seq.*

relations between the universities and industrialists will be worth while only if some mutual benefit can accrue therefrom. This cooperation can therefore be most satisfactorily promoted by actively demonstrating the advantages of the exchange or interchange of subjects for research, which primarily presupposes a reasonable freedom from the concealment of knowledge which persistently adheres to all industrial research.

Industrial research laboratories can be of mutual aid by supplying advice and materials. These laboratories should also publish reports of investigations just as freely as possible and thus, by proving the utility of it, assist in the general scheme of the universities—promote the dissemination of knowledge.

In general, the subcommittee endorses the conclusions of the University and Industry Committee of the New York Section of the American Chemical Society.[7]

THE PROMOTION OF A BETTER APPRECIATION OF RESEARCH

The promotion of a better appreciation of research by the general public can only be obtained by publicity.[8] No complaint can be made of a lack of this at the present time. The large corporations supporting industrial laboratories are themselves expending great sums on giving publicity to their research work. The subcommittee thinks, however, that though the general public now appreciates the value of scientific research, the thing required to increase the number of laboratories is more information as to specific plans for starting and running them. General articles on the advantages of research work would be very much helped in carrying conviction if they were accompanied by definite proposals telling manufacturers of different industries and of different grades in the size of their work what they could do in the way of research work themselves.

The average person who has to decide whether his corporation will support research work can, in the nature of things, know little about it. He desires either to spend much less than is necessary for effective work or he is frightened by the size of the expenditure which he thinks will be necessary. More specific information would enable him to form a truer idea as to what he was committing himself and what he was likely to get.

As far as possible, arrangements should be made for research institutions to have information as to their work available and to persuade them to give this information freely to inquirers. It would be a considerable step in cooperative effort if all the research institutions that can be reached could be persuaded to put information regarding themselves into some form so that a comparison could be made.

THE ESTABLISHMENT OF STABLE RELATIONS BETWEEN RESEARCH INSTITUTIONS AND THE RESEARCH DEPARTMENTS OF INDUSTRIAL PLANTS

The suggestion has been frequently made that the establishment of stable relations between the types of organizations mentioned might be effected if a small group of selected representatives thereof could arrange to confer at regular times. After consideration, the subcommittee recommends the formation of an association of research institutions, that is, an association of all those bodies engaged in scientific and scientific industrial research, including such organizations as the research laboratories of Harvard University, the Massachusetts Institute of Technology, and other educational institutions, the Carnegie Institution laboratories, the Mellon Institute of Industrial Research, and the research laboratories of the corporations which are conducting a certain amount of research of scientific importance. Undoubtedly, an association of this nature would meet with satisfactory support and it would eventually prove an important factor in improving the methods of research organization.

[7] See *J. Ind. Eng. Chem.*, 8 (1916), 658.

[8] It is important to mention here that the American Chemical Society has under consideration the publication of a journal of popular chemistry, a periodical for which there is a real need because of the desirability of the proper dissemination of chemical information to the public.

Stable relations between various research organizations will be worth while only if some mutual benefits can accrue. These can be brought about by an exchange or interchange of "commodities," such as—

(*a*) Subjects for research.

(*b*) Special facilities for extraordinary conditions, such as extreme pressures, extremes of temperatures, etc.

(*c*) Special pieces of expensive apparatus.

(*d*) Helpful ideas on research already in progress.

(*e*) Candidates for employment.

This presupposes a freedom from the secrecy which still surrounds the industrial research of certain organizations. Undue secrecy is unnecessary and unwise, but it is only in those cases where publicity is compatible with industrial progress that full cooperation between the universities and the industries can be effected.

A COMPARATIVE STUDY OF INVESTIGATIONAL ACTIVITIES

This study would be distinctly worth while, but before the initiation of such a movement there must first be established more mutual confidence than now exists. A comparative study of this kind would be very difficult and would necessitate the expenditure of much time. Probably such information could be secured by obtaining the reports regarding the industrial research laboratories in operation, and there is no reason why a suitable questionnaire could not be prepared and distributed, in order to obtain information regarding research conditions and comparative data relating to the organizations maintaining laboratories.

It would be very useful indeed to have available a yearbook pertaining to research laboratories, with the following lines of information: institutions, organizations or concerns supporting them, approximate purpose of laboratory, divisions of science represented therein, manufacturing facilities directly associated therewith, approximate annual expenditure for maintenance of research, number of and particulars relating to the training of the members of the investigatory staff, and, finally, a list of the scientific publications for the past year. Such a book might also advantageously include mention of the special equipment of the laboratories unlikely to be possessed by every similar institution.

The National Research Council, through its committee on research in educational institutions, could well arrange to have some one whose sole duty it was to coordinate the work in university laboratories with reference to general or national welfare. While any attempt which may be made by a national society or association to secure cooperation between industrial and institutional laboratories will invariably encounter the difficulty of invested interests, an organization with governmental support might accomplish much fruitful research work through institutions of learning and in such a way that this would be of material benefit to the institutions concerned, as well as to the nation.

R. F. BACON,
Chairman,
C. E. K. MEES,
W. H. WALKER,
M. C. WHITAKER,
W. R. WHITNEY

PITTSBURGH, PA.,
December 15, 1916

SCIENTIFIC EVENTS

THE CONTROL OF TUBERCULOSIS IN FRANCE

GOVERNOR WHITMAN, of New York, has granted Dr. Hermann M. Biggs, state health commissioner, leave of absence to go to France, at the request of the Rockefeller Foundation, to conduct an organized campaign to combat the spread of tuberculosis among noncombatants. In a letter to Governor Whitman, Mr. Jerome D. Greene, secretary of the foundation, wrote:

> For some time past our representatives in France have been much impressed by the need of effective measures for the relief and control of tuberculosis. A number of voluntary American agencies in France have exerted themselves with great zeal to arouse the sympathy of the American public and to do what could be done to provide hospital care for the more urgent cases that have

come under observation. A committee of French citizens has also been organized in close cooperation with the government, and appeals have been made to us on behalf of the work undertaken by this committee.

In response to the appeals we have received, our representatives have made a careful preliminary study of the situation, and the trustees of the Rockefeller Foundation have been so impressed with the gravity of the need that they have decided to take steps to ascertain definitely the lines along which American sympathy and generosity can be made most effective. With this end in view, they have sought to find the man who in all the country was best qualified both as a physician and as a public health administrator to study the situation in France and to determine the lines along which help could best be given.

They have had no difficulty in making up their minds that Dr. Herman M. Biggs was the man whose character and attainments best fulfilled the requirements of the case. They realized that it would be asking a great deal of Dr. Biggs to make the sacrifice involved in a visit to France, and that the state of New York had the first claim on his services. They felt, however, that if it should be the happy result of Dr. Biggs's going to France that the benefits of his long and wonderfully fruitful service in New York could be availed of in the organization of the campaign in that country, the effect in terms of human welfare would be so large and far-reaching as to constitute a very strong claim both on his public spirit and upon the generosity of the state of New York.

During Dr. Biggs's absence Dr. Linsly R. Williams, deputy commissioner, will be acting commissioner; Dr. Matthias Nicoll, Jr., now secretary of the board, will be acting deputy commissioner, and Dr. John A. Smith, at present sanitary supervisor, will act as secretary.

THE NATIONAL PARKS CONFERENCE

UNDER the auspices of the National Park Service of the Department of the Interior there was held in the auditorium of the New National Museum, Washington, D. C., on January 2, 3, 4, 5 and 6, 1917, a National Parks Conference, at which many important papers and lectures were presented. The program included:

Our National Parks: Franklin K. Lane, secretary of the interior; Senator Reed Smoot, of Utah; Representative Scott Ferris, of Oklahoma; Representative Irvine L. Lenroot, of Wisconsin; Carl Vrooman, assistant secretary of agriculture; Enos Mills.

Canadian National Parks: J. B. Harkin, commissioner of Dominion Parks, department of the interior, Canada.

The Public and the National Parks: Huston Thompson, Jr., assistant attorney general.

University Classes in the National Parks: Professor E. M. Lehnerts, of the University of Minnesota.

Public Schools and the National Parks: Philander P. Claxton, U. S. Commissioner of Education.

National Parks as a Scientific Asset: Dr. Charles D. Walcott, secretary, Smithsonian Institution.

Teaching by Picture: Gilbert H. Grosvenor, editor, *National Geographic Magazine*.

The Painter and the National Parks: William H. Holmes, head curator, National Gallery of Art.

The Photographer and the National Parks: Fred H. Kiser.

National Forests and National Parks in Wild Life Conservation: Henry S. Graves, forester and chief, Forest Service.

The Yellowstone Elk Herds: E. W. Nelson, chief of the Bureau of Biological Survey.

Future of the Antelope: E. Lester Jones, superintendent, Coast and Geodetic Survey.

National Monuments as Wild Animal Sanctuaries: T. S. Palmer, assistant in charge of Game Preservation, Bureau of Biological Survey.

Colossus of Canyons: Representative Simeon D. Fess, of Ohio.

The Survey's Contribution to the National Park Movement: Dr. George Otis Smith, director, U. S. Geological Survey.

The Problem of the Greater Sequoia: Representative Frederick H. Gillett, of Massachusetts.

Perhaps Our Greatest National Park: Enos Mills.

The Tehipite Valley and Kings Canyon: Robert Sterling Yard.

The Top of America—Mount Whitney: Emerson Hough.

A FRENCH NATIONAL PHYSICAL LABORATORY

THE question of national laboratories of scientific research has been brought forward recently in France. In the *Comptes rendus* of the Academy of Sciences for November 13, as summarized in *Nature*, is a preliminary

report by a committee composed of MM. Jordan, Lippmann, Emile Picard, d'Arsonval, Haller, A. Lacroix, Tisserand and Le Chatelier on this question. It is pointed out that all the great industrial nations possess national laboratories of scientific research, systematically directed towards the study of technical problems. The National Physical Laboratory in England, the Bureau of Standards and the Carnegie Institution in the United States, the Physikalische Reichsanstalt and the institutes founded by the Wilhelm Gesellschaft in Germany are given as examples. France has no corresponding institution, and after a full discussion of the questions of control, staff, and work to be done, the following resolution was unanimously carried:

> The Academy of Sciences, convinced of the necessity of organizing in France, in a systematic manner, certain scientific researches, expresses its wish that a National Physical Laboratory should be started, for the prosecution of scientific researches useful to the progress of industry. As in other countries, this laboratory would be placed under the control and direction of the Academy of Sciences.

On November 27 this question was further considered by the academy, and it was suggested that the general direction of the laboratory should be entrusted to a council, one half of the members to be nominated by the academy, one quarter representatives of the state departments, and the remaining quarter delegated by the principal industrial interests. Certain existing state laboratories might be affiliated to the national laboratory. A considerable grant for establishment and maintenance will be necessary.

DEDICATION OF THE NEW YORK STATE MUSEUM

ALTHOUGH the New York State Museum at Albany has been open to the public for some months past, it seemed wise to the regents of the university to bring the public into closer touch with the new museum by formal dedicatory exercises. These took place in the chancellors' hall of the education building at Albany on the afternoon and evening of Friday, December 29. The afternoon exercises consisted of a series of addresses from eminent speakers, each representing a special phase of community interest in the museum. The Honorable Charles B. Alexander, chairman of the regents committee of the State Museum, presided, and the speakers were President John H. Finley on behalf of the university and the educational system of the state; Senator Henry M. Sage on behalf of the state government; Doctor Francis Lynde Stetson on behalf of the people; the Honorable Charles D. Walcott, speaking as a representative of science in its broadest sense, and Director John M. Clarke on behalf of the museum.

In the evening the principal address was by Colonel Theodore Roosevelt, who spoke under the title "Productive Scientific Scholarship," and gave an interesting speech to a large audience. Colonel Roosevelt was introduced by Governor Charles S. Whitman, who very happily set forth the value of the research work of the scientific corps attached to the museum. The evening exercises were felicitous and successful throughout, and were followed by a reception in the halls of the museum. Colonel Roosevelt's address on this occasion, or the part of it that related especially to his scientific theme, has been already printed in SCIENCE, and all the addresses of the occasion will be published as a bulletin of the university.

SCIENTIFIC NOTES AND NEWS

PROFESSOR FRANK D. ADAMS, of McGill University, has been elected president of the Geological Society of America. Dr. Charles P. Berkey, of Columbia University, continues as acting secretary, in the absence in the Arctic regions of Dr. E. O. Hovey.

OFFICERS of the Mathematical Association of America elected at the New York meeting, on December 29, are: *President,* Florian Cajori, Colorado College; *Vice-presidents,* Oswald Veblen, Princeton University, and D. N. Lehmer, University of California; *Secretary-treasurer,* W. D. Cairns, Oberlin College; *Members of the Council* to serve until January, 1920: E. R. Hedrick, University of Missouri; Helen A. Merrill, Wellesley College; R. E. Moritz, University of Washington; D. E.

Smith, Columbia University; *Member of the Council* to take the place of Florian Cajori (elected president): E. V. Huntington, Harvard University.

Dr. F. W. Taussig, professor of political economy at Harvard University, is reported to have accepted the chairmanship of the tariff commission created by the present congress.

The title of emeritus professor of physics in the University of London has been conferred by the senate on Dr. F. T. Trouton, who held the Quain chair of physics until 1915.

Dr. A. Yersin, director of the Pasteur Institute of Indo-China, has been awarded the Lasserre prize for the present year for his work on anti-plague serum.

Privat-Dozent J. Kyrle, of the University of Vienna, has been awarded $200 by the Austrian Academy of Sciences to continue his experimental researches on leprosy.

Mr. William Grunow, eighty-seven years old, who was for thirty-six years custodian of the United States Military Academy Observatory at West Point and a skilled instrument-maker, died on January 5.

A correspondent writes that Mr. Orville Wright has moved into his recently completed laboratories at Dayton, Ohio. The death of Wilbur Wright a year ago caused the suspension of work on the problems of aviation for a time. But in November Mr. Wright resumed flying at his aviation field and dropped his experiments only when the winter weather interfered. Mr. Wright states that there are certain experiments having to do with the theoretical side of aeronautics which the Wright brothers had made prior to 1905. They gave up experimentation for flying. One of the experiments with which Orville Wright will busy himself is the wind funnel. He began observing the effect of wind currents on plane surfaces early in the year. As soon as spring comes, Mr. Wright will begin flying again at his aviation field and will continue his experiments in the new laboratories.

Professor Frederick E. Breithut, of the department of chemistry of the College of the City of New York, has issued a report to the *New York Section of the American Chemical Society*, urging a statistical investigation of the chemists of the United States so that the conditions of employment and opportunities for young men entering the profession may be ascertained. The committee, appointed by Dr. J. Merrit Matthews, chairman of the New York Section, consists of Professor Frederick E. Breithut, chairman; Elwood Henrick, Bernhard C. Hesse and Otto H. Klein.

Dr. Richard M. Pearce, the John Herr Musser professor of research medicine in the University of Pennsylvania and adviser in medical education to the International Health Board of the Rockefeller Foundation, sails on January 15 for Argentina and Uruguay to study medical conditions in these countries.

A grant of $250 has been made by the C. M. Warren Committee of the American Academy of Arts and Sciences to Professor E. L. Mark, of Harvard University, for the investigation of certain properties of sea water at the Bermuda Islands.

The Association of Military Surgeons of the United States has announced the results of the Henry S. Wellcome prize competition. Capt. Mahlon Ashford, of the Army Medical Corps, who wrote on "The Organization of Medical Officers," was awarded a gold medal and $300. A silver medal and $200 was awarded to Assistant Surgeon-General W. C. Rucker, of the Public Health Service, whose essay was entitled: "The Influence of the European War on the Transmission of the infections of Disease."

Under the Herter Foundation the faculty of the University and Bellevue Hospital Medical College announces five lectures by Professor Archibald B. Macallum, of the University of Toronto, on "The Distribution of Inorganic Compounds in Animal and Vegetable Tissues and the Forces that determine it." These lectures began January 8, at 4 o'clock, at the Carnegie Laboratory, and will continue daily at the same hour.

Dr. Forest Ray Moulton, professor of astronomy in the University of Chicago, will give in February, five lectures at Western Reserve University on the MacBride Foundation.

WE learn from *Nature* that a fund is being raised to purchase the very valuable scientific library of the late Professor Silvanus Thompson and to present it to the Institution of Electrical Engineers as a memorial of his life and work, the library to be accessible to the public on the same conditions as the Ronalds Library. Those who wish to subscribe to this fund or to have further information regarding it are requested to communicate with Mr. W. M. Mordey, 82 Victoria Street, London, S.W.

A CORRESPONDENT writes: "In the death, on December 2, of Dr. Herbert Armistead Sayre, professor of mathematics and sometime professor of physics at the University of Alabama, there passed a true gentleman, and thousands of his past students will ever keep within their hearts a warm appreciation of his kindly friendliness and sterling worth."

THE death is announced of Mr. William Ellis, F.R.S., in his eighty-ninth year. Mr. Ellis was formerly superintendent of the Magnetical and Meteorological Branch of the Royal Observatory, Greenwich. He joined the Observatory in 1841, and was attached to the astronomical department until 1874, having during the preceding eighteen years been in charge of the chronometric and electric branch.

DR. RAYMOND TRIPIER, former professor of pathologic anatomy at the Lyons School of Medicine, has died at the age of seventy-eight years.

WORD has come to this country of the death on the battlefield at Artois, France, on September 15, 1915, of Dr. Bernard Collin, of the staff of the zoological station of the University of Montpelier, situated at Cette. Dr. Collin had made a brilliant record by his researches on the cytology of the Suctoria and was regarded as one of the most promising of the younger protozoologists of France.

UNIVERSITY AND EDUCATIONAL NEWS

THE University of Cincinnati has received by the will of Francis H. Baldwin, of Cincinnati, a bequest of approximately $675,000 for the unspecified uses of the university.

JEFFERSON MEDICAL COLLEGE at Philadelphia has received a gift of $150,000 from Miss Anna J. Magee to endow the Magee professorship for the practise of medicine and clinical surgery, now held by Professor Thomas McCrae. During the year, the college has received $100,000 from Daniel Baugh to establish the provost professorship of therapeutics, held by Dr. Hobart A. Hare, and an equal sum from friends of the college to endow the Samuel D. Gross professorship of surgery, held by Dr. J. Chalmers Da Costa. It is understood that these gifts are intended to make unnecessary the merging of the Jefferson Medical College with the Medical School of the University of Pennsylvania.

THE board of trustees of the Emma Willard School, Troy, N. Y., announces that, continuing her benevolence toward this school and the new Russell Sage College of Practical Arts, Mrs. Russell Sage has given $250,000 toward the advancement of the work of this latter institution, the only requirement being that the money so given should be used the same way as the original gift of a like amount a year ago to establish the college.

FRIENDS of the University College of Wales, Aberystwyth, have expressed their intention of contributing £100,000 to the funds of the college, subject to a reservation of their right to make proposals to the council as to either the capital or the income.

HAROLD VEATCH BOZELL, E.E., director of the University of Oklahoma Electrical Engineering School, is temporarily serving on the Sheffield Scientific School faculty of Yale University. Dr. Alois Francis Kovarik has been appointed assistant professor of physics in the school.

MR. F. R. GRIFFITH, JR., A.M. of Washington University, who has been research assistant in physiology at Tulane University, has been elected assistant professor of biology at Southern Methodist University, Dallas, Texas.

DR. H. A. L. FISHER, vice-chancellor of Sheffield University, has been appointed president of the Board of Education in the new British cabinet.

DISCUSSION AND CORRESPONDENCE

A CASE OF SYNCHRONIC BEHAVIOR IN PHALANGIDÆ

A recent article in this journal by Wallace Craig on "Synchronism in the Rhythmic Activities of Animals" recalls to mind an observation that I made near Austin, Texas, in 1909. At the time of the observation I made some field notes from which the following description is taken.

While engaged in hunting various species of rock lizards I located a vast colony of "harvestmen," which I identified as belonging to the genus *Liobunum,* resting during the day on the under side of an overhanging shelf of rock on a precipitous hillside. In a somewhat circular area of nearly five feet in diameter the harvestmen were packed closely together in almost unbelievable numbers. I estimated that there were between one and two thousand in the colony. When I first saw them they were all hanging from the ceiling, as it were, perfectly motionless, but when I came within about six feet of them they began a curious rhythmic dance. Without changing their foot-holds they raised their bodies up and down at the rate of about three times a second, and, curiously enough, the movement of the entire lot was in the most perfect unison. This performance was kept up for over a minute and then stopped gradually as though from exhaustion. I then poked a few of the nearest individuals with a stick and these immediately resumed the rhythmic up-and-down movement, which spread quickly over the whole group, but died down in less than half a minute. When I once more stirred up a few individuals they gave a few rhythmic responses, which stirred the whole colony again, but only slightly. After this a number of individuals began to crawl about and it was no longer possible to stimulate the rhythmic behavior.

When the colony was first seen it was noted that the long legs of neighboring individuals were closely interlocked and this mechanism was sufficient to account for the transmission of stimuli from one part of the colony to another. It should be noted especially that the rhythm was not perfectly synchronous at the beginning, but became so after a few seconds.

Possibly synchronic flashing in fire-flies may be explained as the result of a somewhat similar transmission of stimuli. One flash stimulates others, which at first might lag slightly; but soon a synchronism is built up in a limited region, such as one bush or one tree. Such a synchronism might be transmitted to a whole field.

It would be interesting to know whether any other naturalist has observed the type of behavior herewith described for the Phalangidæ.

H. H. Newman

University of Chicago

THE SUPPOSED SYNCHRONAL FLASHING OF FIREFLIES

I was very much interested in reading the article by H. A. Allard, entitled "The Synchronal Flashing of Fireflies," which appeared in Science, November 17, 1916. Some twenty years ago I saw, or thought I saw, a synchronal or simultaneous flashing of fireflies (Lampyridæ). I could hardly believe my eyes, for such a thing to occur among insects is certainly contrary to all natural laws. However, I soon solved the enigma. The apparent phenomenon was caused by the twitching or sudden lowering and raising of my eyelids. The insects had nothing whatsoever to do with it. Many times in the past twenty years I have proved that my solution was correct.

Philip Laurent

TRIMMED MAGAZINES AND EFFICIENCY EXPERTS

To the Editor of Science: I have been reading your article on page 13 of Science for January 5 entitled "Science and the Cost of Paper" and am very sorry that the price of paper has increased to such an extent that you have to make a material change in Science. I understand your position and am not objecting the slightest to what you are doing; but I do want to make a protest against this popular efficiency humbug, because it seems to me that people are running the efficiency matter into the ground. It's all nonsense for any efficiency expert to say that the opening

of SCIENCE by hand cost scientific men $10,000 per year. Of course it might if men sat down and opened the magazine and then afterwards read it through, but I have always found that I got more out of an unopened magazine than an opened one, because I would more carefully examine a magazine that I had to open than one that was opened; because, as I opened it, I either read the magazine, or if I didn't want to read the articles, got a rough idea of them as I opened the magazine, and for that reason whenever possible I try to get an unopened magazine.

We are losing in this nonsense regarding efficiency a good deal of the human interest in men in our employ and it's a great question to my mind if efficiency is not doing more damage than good. H. P.

[The editor shares to a certain extent his correspondent's prejudice against trimmed magazines and efficiency experts. An untrimmed journal looks as if it were waiting for careful reading and the binder; a trimmed one for a hasty glance and the waste-paper basket. This, however, is a matter of association, which is already changing with general usage. Trimmed magazines and efficiency experts have apparently arrived. We must get used to the one and treat the other with discretion.]

SCIENTIFIC BOOKS

Die Kultur der Gegenwart. Herausgegeben von PAUL HINNEBERG. Teil III., Abtlg. III. Physik, S762. Teubner, 1915.

During the past two years much has been written about Kultur. There has been a tendency in the English-speaking world to identify it with "culture," a term which with us is variously defined. While our dictionaries may give as the equivalents of culture the following: knowledge, development, the training of the mind, the intellectual side of civilization —the more common use of the English word is associated with refinement, taste, manners. It is this common meaning which leads Stephen Leacock to speak of a cultured man as "one who has acquired a silk hat and the habit of sleeping in pyjamas." Associating culture with refinement we generally think of it as denoting knowledge of fine arts, of music, literature, languages, especially *ancient* languages. Indeed, John Bright complained that the only necessary qualification of a cultured man was that he possess a *smattering* of two *dead* languages, Latin and Greek. Gradually, however, we are getting away from identifying culture with a knowledge chiefly of languages, living, dead and half dead, with taste and manners, and are coming to view it as "that complex whole which includes knowledge, belief, art, morals, law, custom and any other capabilities and habits acquired by man as a member of society." In this view we are approaching the idea of "Kultur" as set forth in this volume and its companions in the series. In passing it should be noted that even among Germans there are a variety of views concerning "Kultur." Professor Münsterberg defines it as "the consciousness of nationalism, the subordination of the individual to the national ideal." But if one desires to ascertain the meaning of "Kultur" as here set forth, one should read the 760 pages of this volume which is concerned only with physics. One then should survey the contents of the other fifty-seven volumes of the "Kultur" series.

The fifty-eight volumes comprising "Die Kulture der Gegenwart" are divided as follows: fourteen are devoted to religion, philosophy, literature, music, art; ten to history, economics, the political and social sciences; nineteen to mathematical, natural and medical sciences; fifteen to technical sciences.

In the volume under review there is presented the philosophical evolution rather than the history of physics. *Ideas* are traced from their origin to their present fullness. One is thus able to observe how the contributions of the succeeding centuries and decades compare with one another. It is interesting to note that in the article on mechanics, which may be regarded as the *oldest* portion of physics, thirty-six pages suffice to bring the subject to near the end of the nineteenth century and twenty-five pages are given to the development during the past generation. In the other thirty-five articles thirteen are almost en-

tirely concerned with the developments of the past twenty-five years and the other articles are largely taken up with such development. Obviously physics is a new subject and Kultur has grown in recent years.

The thirty-six articles in this volume are contributed by thirty-two specialists, all Germans with two exceptions—H. A. Lorentz and P. Zeeman. The assignment of subjects to writers is, with perhaps a couple of exceptions, that which an American physicist would make. Thus H. Rubens writes on Wärmestrahlung; W. Wein on Theorie der Wärmestrahlung; Dorn on Experimental Atomistik; Einstein on Theoretische Atomistik and Die Relativitätstheorie; Lorentz on Die Maxwellsche Theorie and Die elektronen Theorie; P. Zeeman on Magnetooptik; Lecher on Die Entdeckungen von Maxwell und Hertz; Braun on Die Drahtlose Telegraphie; Kaufmann on Die Kathodenstrahlen und Die Röntgenstrahlen; Max Planck on Das Prinzip der kleinsten Wirkung und Verhältniz der Theorie zucinander. We are rather surprised to see that the article on Die Positiven Strahlen is given by Gehrcke and Reichenheim rather than by Starke. To the latter is assigned Das Elektrische Leitungsvermögen. A detailed and technical review of this large work is here impossible, but certain general characteristics may be noted.

The authors treat their respective topics in a general and philosophic manner. One rather striking point is that, except in an occasional appendix and except as they are required for the condensed statement of a physical law, mathematical equations do not occur. The reader of this volume will not be troubled by analytical difficulties. In this respect the articles in this volume offer a striking contrast to those on similar topics in the Encyclopædia Britannica.

All of the material contained in these articles can be found scattered through the earlier handbooks or the recent scientific periodicals. The criticism may therefore be made that this volume tells a physicist nothing with which he is not already acquainted, while it is of no value to one who is not a physicist, by reason of the fact that the latter would be unable to follow the condensed argument. This criticism, however, is rather forced. Many physicists who have been carrying on intensive work in limited fields will find here a very acceptable summary of those portions of the subject with the literature of which they have not been able to keep in touch.

As the contributors of the articles in this volume are almost all Germans, it is natural that the work of German physicists should receive adequate, perhaps unduly favorable, recognition. Thus Helmholtz is given credit for originating the present electron theory through the emphasis he placed upon Faraday's statement concerning the absolute quantity of electricity associated with the particles or atoms of matter. Probably most physicists have come to the conclusion that Faraday stated for electrolysis in as clear language as it could be stated the law of multiple proportions of electricity and matter.[1] Helmholtz had no more experimental evidence than had Faraday to extend this law beyond the field of electrolysis. It required the work of Schuster, Perrin, Kaufmann, Wilson, J. J. Thomson, to complete the statement. If we are going to give credit along this line to any one between Faraday and these later workers, we should not lose sight of the fact that in 1871 before the British Association, Johnstone Stoney spoke of the quantity of electricity appearing in electrolysis as the *natural unit* and later gave to it the name electron—a name which has been retained.

Ordinarily the writers of articles have not overstated the importance of their own contributions, but in the article on Wireless Telegraphy by Ferdinand Braun full justice is done to the author's experimental work.

Passing from electricity to thermodynamics one is surprised to see even in a minor paragraph the name of Holtzmann preceding that of Joule in connection with the determination of the mechanical equivalent of heat. We know that Holtzmann by his work on the specific heat of gases made a contribution of some importance and that he computed the mechanical equivalent of heat—but his ideas were hazy as to the nature of heat, for

[1] See "Experimental Researches," Vol. I., par. 852.

at times he assumed, as did Carnot, that the quantities of heat entering and leaving the cylinder of an engine, irrespective of the performance of work, were equal. If for the sake of completeness Holtzmann's work be referred to in this volume, so too should that of Marc Léguin (1839), who as far as the performance of an engine is concerned anticipated other workers (except possibly Rumford and Davy) in a partial statement of the law of the equivalence of heat and work.

Had this volume been written by American physicists, emphasis would have been placed on parts of the subject not here noticed. Wood on resonance spectra, Nichols and Merritt on fluorescence, Miller, Webster, Sabine on sound, Michelson on the rigidity of the earth, Pupin, G. W. Pearce on wireless telegraphy, would have been recorded.

But when we come to view the great body of philosophical thought which has come to us in this past generation we must give to Teutonic physicists credit for a large share. Boltzmann's conception of the entropy of a body in terms of the probability of state; the extension by Planck of the idea of entropy and temperature to radiation, leading to the distribution of energy in the spectrum of a full radiator and to the bewildering quantum theory; Einstein's contributions to molecular theory and to the theory of relativity—these stand out as substantial portions of "Die Kultur der Gegenwart." G. F. HULL

SPECIAL ARTICLES

PEANUT MOSAIC

ON September 28, 1915, while looking over a field in which peanuts (*Arachis hypogæa*) had been grown annually for the past six years a plant was observed, one shoot of which bore mottled leaves. A careful search of the entire field was made, but no other plant bearing mosaic leaves was found. This made the writer suspect that the trouble was not infectious. It seemed advisable to test this point further, especially since the mosaic plant was otherwise healthy except for a few leaf spots produced by *Cercospora personata*.

This mosaic plant was transferred to the greenhouse. Before final potting two of the mature pods were removed from the plant and opened, and four peas taken from them were planted at once in a pot of greenhouse soil. The four resulting plants together with two other seedlings which came up later from peas left on the mosaic plant, have been under observation during the past five months. In no case have any signs of mosaic developed. It would thus appear that this mosaic was not carried by the seed.

The transplanted mosaic plant continued to grow and produce new leaves at the ends of the shoots, but in no case did any but the mosaic shoot produce new mosaic leaves.

To obtain further data as to the infectious nature of this mosaic a pot of four peanut plants from a 1914 crop of seed was selected. Two plants were slashed near the ends of the shoots with a flamed scalpel to serve as checks. The other two plants were treated in a similar way, except that into the slashed stems bits of macerated mosaic leaflet were inserted. These plants have been under observation for the past five months but no signs of mosaic have developed on either the checks or inoculated plants.

On October 14, 1915, a pot containing peanut plants from the 1914 seed was taken to the laboratory. By means of India ink circular areas were marked on each leaflet of one plant. Within these circles the tissues were pierced several times with a flamed dissecting needle. This plant served as a check. The second plant in the same pot was treated in a similar way except that before piercing the leaf tissues the needle was moistened in the juice from mosaic leaflet freshly removed from the potted mosaic plant. Similar checks and inoculations were made on garden peas (*Pisum* spp.) growing in pots, using juice from the mosaic peanut leaflet. On November 13, 1915, the above plants were carefully examined, but neither the checks nor the inoculated plants showed any sign of mosaic on either young or old leaves.

On November 13, 1915, to further test the infectious nature of this peanut mosaic one check was prepared by injuring each leaflet of the plant by pinching it between the thumb

and finger nail. Eight other plants of the same age and all from the 1914 crop of seed were treated similarly except that the finger nail was moistened in macerated mosaic leaves before pinching each leaflet to be inoculated. Over three months have elapsed since the above inoculations were made, but no signs of mosaic have developed on any of the checks or on the inoculated plants. On all the leaves, however, the scars of the finger nail injury are visible.

As the original mosaic plant has matured in the meantime, leaving no fresh leaves to use for inoculation, it seems advisable to present this data so that others may be led to record any observation they may make along this line.

J. A. McClintock
Virginia Truck Experiment Station

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION C—CHEMISTRY—AT THE NEW YORK MEETING

On Wednesday, December 27, at Columbia University, there was a joint session of Sections B and C, the American Chemical Society and the American Physical Society, devoted to a symposium on the structure of matter. The attendance was very large, and Havemeyer Hall was filled to capacity. The main items on the program have already been printed in a recent number of Science.[1] These papers[2] and the subsequent discussion brought out the fact that there is still a wide divergence between the various views, particularly between those of the physicist and those acceptable to the chemist; the mere fact of such a divergence of view emphasizes the usefulness of this discussion—and, indeed, of further discussion—of this very important topic.

On Thursday, December 28, Section C met with the American Chemical Society and the Society of Chemical Industry at the College of the City of New York, when the following addresses were presented:

Dr. William McPherson, retiring chairman of Section C, professor of chemistry, Ohio State University, "Asymmetric Syntheses and their Bearing upon the Doctrine of Vitalism."

Dr. Phoebus A. Levene, Rockefeller Institute for Medical Research, "The Individuality of Tissue Elements."

Dr. Hugh S. Taylor, Princeton University, "The Photo-Chemistry of the Chlorination Processes."

Dr. George F. Kunz, New York City, "Preparedness Chemistry Exhibit of the United Chemical Societies at the American Museum of Natural History."

Dr. C. G. Derick, Buffalo, "Equilibrium Constants and Chemical Structure."

Dr. S. Dushman, Schenectady, "Application of Atomic Theories in Chemistry."

Through the courtesy of the college, a complimentary luncheon was tendered to the section, which was highly appreciated. In the afternoon the following papers were read:

A Preliminary Report of the Chemical Committee of the National Research Council, by Marston Taylor Bogert, chairman.

"An Increase in the Sucrose Content of Sugar Beets after their Removal from the Soil," by F. G. Wiechmann.

"Valency and Valence," by M. L. Crossley.

"Conductivity Measurements on Oxidation-Reduction Reactions," by Graham Edgar.

"Stability of Paraffin Hydrocarbons," by G. Egloff and R. J. Moore.

The following by title only:

"The Effect of Fineness of Division of Pulverized Limestone upon Various Crop Yields," by N. Kopeloff.

"A Relation between the Chemical Constitution and the Optical Rotatory Power of the Phenylhydrazides of Certain Acids of the Sugar Group," by C. S. Hudson.

"*d*-Mannoketoheptose. A New Sugar from the Avocado," by F. B. La Forge.

Section C elected new officers, as follows:

Vice-president and Chairman of the Section: Professor W. A. Noyes, University of Illinois.

Secretary: Professor James Kendall, Columbia University.

Member of Council: Professor M. A. Rosanoff, Pittsburgh.

Member of General Committee: Dr. R. F. Bacon, Pittsburgh.

Member of Sectional Committee: Dr. Irving Langmuir, Schenectady.

John Johnston,
Secretary

[1] Vol. 44, p. 885, 1916.

[2] It will, we hope, prove feasible to have all of these papers printed together in some suitable place.

SCIENCE

FRIDAY, JANUARY 19, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ASYMMETRIC SYNTHESES AND THEIR BEARING UPON THE DOCTRINE OF VITALISM[1]

IN the history of the development of any science certain discoveries stand out boldly as epoch-making in importance. In the domain of organic chemistry the observations of Liebig and Wöhler (1826) that cyanic and fulminic acids have the same percentage composition, rank with this class of discoveries; for the establishment of this fact laid the foundation for the development of the principle of isomerism. Likewise to this class belongs the investigation of Wöhler (1828) in which he proved that urea results from the spontaneous rearrangement of ammonium cyanate, a discovery of no great significance in itself, but of the greatest importance when regarded from its bearings upon the ideas concerning organic compounds prevalent in the first quarter of the nineteenth century; for it carried with it the abandonment of the universal belief that compounds elaborated within the living organism can not be prepared synthetically by laboratory methods. Following Wöhler's classical discovery came those brilliant investigations of Pasteur (1844–49) on the tartaric acids which led to the development of our modern ideas concerning space-isomerism or stereo-isomerism.

Since it is my purpose to deal with a certain phase of stereo-isomerism I will re-

[1] Address of the vice-president and chairman of Section C, Chemistry, American Association for the Advancement of Science, New York, December, 1916.

view briefly a few of the important discoveries that led up to the investigations of Pasteur. These discoveries are outlined in the historical introduction of Pasteur's lectures delivered before the Chemical Society of Paris in 1860.

The fact that a ray of light in passing through a crystal of Iceland spar is divided into two rays had been known for many years, but it remained for Huygens and Newton in 1678 to point out that the ray of light is altered in its properties as it passes through the crystal. Later in 1808 Malus was able to show that light was similarly altered in properties by being reflected from any object and designated this change in properties by the term "polarization." Malus followed up this discovery with a number of important observations, but his early death at the age of 37 ended his brilliant career. The work, however, was continued by two young physicists Arago and Biot, and the latter devoted a long life primarily to the study of polarized light and its attending phenomena. It was Biot who observed that plates cut from certain quartz crystals rotate the plane of polarization to the right while similar plates cut from other quartz crystals rotate it to the left. In 1815 he announced to the Société philomatique the very important discovery that this property of rotating the plane of polarization is not confined to solids; for solutions of certain organic compounds, including sugar, camphor and tartaric acid likewise cause a rotation of the plane. Biot's studies led him to the definite conclusion that while both the quartz crystal and the sugar solution rotate the plane of polarization, the rotation in the two cases is due to different causes. In the former case the crystalline structure must be the influencing factor, for silica in the amorphous state does not rotate the plane of polarization. On the other hand, the ability of the sugar solution to rotate the plane of polarization must lie in the structure of the sugar molecule.

Another important observation in connection with this general subject was made by Hauy and Weiss, who noted in their study of quartz crystals that some of the crystals possessed certain faces truncating the upper edge of the prism face. They observed, moreover, that these faces or planes did not occupy the same position on all crystals; that in some, the plane appeared on (say) the right upper edge while in others it occupied a similar position on the corresponding left edge. With this difference as a basis, the crystals could be divided into two groups, the members of which are related to each other as object is to image, or as the right hand is to the left. It was Herschel who suggested (1820) that the difference in the optical activities of the quartz crystals, as noted above, might be connected with the position of these truncating planes on the crystal, and that of the two groups of crystals referred to, the members of the one group might rotate the plane of polarization in the one direction while the members of the other group might rotate it in the opposite direction. Experiments soon proved the verity of Herschel's suggestion.

THE INVESTIGATIONS OF PASTEUR BEARING UPON ASYMMETRY

The above account gives briefly the state of the knowledge of polarization when Pasteur began his now classical investigations. In order to familiarize himself with crystals, Pasteur decided to repeat some important research in this field of study—a method which may well be recommended to all who are in training for research work. For this purpose he chose the investigations of de La Provostaye on the tartaric acids published in 1841. In this study Pasteur soon

discovered what had escaped the eyes of even so keen an investigator as de La Provostaye, namely, that the crystals of the tartrates possessed truncating planes analogous to those observed in the quartz crystals. He found, however, that in the case of the crystals of the salts of the optically active tartaric acid (dextro-tartaric acid) these planes all occupied the same relative position so that the crystals were all identical. On the other hand, the crystals of the salts of the optically inactive tartaric acid (racemic acid), like the quartz crystals, could be divided into two groups according to the position of the planes, the members of the one group being related to those of the other as object is to image. It was but a step to show that, of the two groups of the crystals formed by the salts of the inactive acid, the one group rotated the plane of polarization to the right while the other rotated it an equal amount to the left; that the acid prepared from the group of crystals which rotated the plane of polarization to the right was in every way identical with the well-known dextro-tartaric acid and that the acid prepared from the remaining group of crystals was identical with the dextro acid in every respect except that it was levorotatory.

Here then, lay the secret of the optical inactivity of racemic acid, as well as the secret of the relation of the racemic acid to the ordinary active tartaric acid.

Pasteur realized the importance of his results. Vallery-Radot in his fascinating life of Pasteur gives a vivid account of the discovery. After referring to the final experiment in which Pasteur had tested the activity of the two sets of crystals in the polarizing apparatus, the biographer continues:

His excitement was such that he could not look at the apparatus again; he rushed out of the laboratory, not unlike Archimedes. . . . Never was there greater or more exuberant joy on a young man's lips. He foresaw all the consequences of his discovery. The hitherto incomprehensible constitution of paratartaric or racemic acid was explained; he differentiated it into right-hand tartaric acid, similar in every way to the natural tartaric acid of grapes, and left-hand tartaric acid. These two distinct acids possess equal and opposite rotatory powers, which neutralize each other when these two substances, reduced to an aqueous solution, combine spontaneously in equal quantities.

The discovery was received with the greatest interest by the French scientists. The story is well known of how Biot, then an old man, wishing to learn more about the work before presenting it to the French Academy, invited Pasteur to repeat the experiments in his laboratory, using solutions which Biot himself had prepared, and how upon the completion of the experiments he grasped Pasteur's hand, saying:

My dear child, I have all my life so loved this science that I can hear my heart beat with joy.

Pasteur had connected the different effects of the dextro- and levo-tartaric acids with the asymmetrical character of their molecules. I quote from him:

We know, in fact, on the one hand, that the molecular arrangement of both tartaric acids is asymmetric; on the other, that they are entirely the same, with the exception that the asymmetry is shown in opposite senses. Are the atoms of the dextro acid arranged in the form of a right-handed spiral, or are they situated at the corners of an irregular tetrahedron, or do they have some other asymmetric grouping? This we do not know. But without doubt the atoms possess an asymmetric arrangement like that of an object and its reflected image.*

Following the work of Pasteur, Wislicenus in 1873 made an extended study of the different isomeric lactic acids and concluded that the existence of these could be explained only upon the assumption that their differences are due, not to different groups of atoms, but to a different arrangement of the same groups in space.

It remained for van't Hoff and Le Bel in 1874 to propose a theory which gives a satisfactory explanation of the facts. These

two scientists working independently reached almost identical conclusions at about the same time, van't Hoff presenting his views in a brochure published at Utrecht in September, 1874, while Le Bel's article appeared two months later in the November issue of the *Bulletin de la Société Chimique de Paris*. In accordance with the views advanced by van't Hoff and Le Bel every molecule containing a carbon atom attached to four different groups (a so-called asymmetric carbon atom) may exist in two forms related to each other as object is to image. The one form of molecules rotates the plane of polarization to the right, the other form rotates it an equal extent to the left. It follows, therefore, that a compound containing an asymmetric atom may be expected to exist in three forms: the dextro or *d*-form composed of those molecules which rotate the plane of polarization to the right; the levo or *l*-form composed of those molecules which rotate the plane of polarization to the left; and the inactive or racemic form which consists of a true chemical combination of the two kinds of molecules in equal quantities. It is also possible to have equimolecular inactive mixtures of the dextro and levo forms.

This theory of van't Hoff and Le Bel, well known and therefore but briefly sketched, was vigorously opposed and even ridiculed when first advanced. Kolbe referred to it in the following terms:

> A Dr. J. H. van't Hoff, stationed at the veterinary school at Utrecht, as it appears, finds no pleasure in exact chemical investigations. He has deemed it easier to mount Pegasus (evidently borrowed from the veterinary school) and in his "Chemistry in Space" to announce how the atoms lying about in the universe, appeared to him from the chemical Parnassus which he had climbed in his bold flight. . . . To criticize this writing even in a half way thorough manner is not possible, because the fantastic absurdities are entirely lacking in actual foundation and are entirely incomprehensible to the sober-minded investigator.

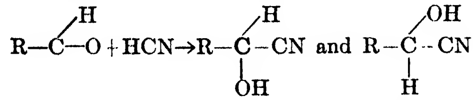
Notwithstanding these criticisms the theory advanced by van't Hoff and Le Bel has stood the test of experiment better perhaps than any other theory ever advanced within the domain of organic chemistry and has been a most potent factor in the development of stereo-chemistry.

THE SYNTHESIS OF ASYMMETRIC COMPOUNDS

To me the most interesting problem belonging to the general subject of stereochemistry is that of synthesizing compounds containing an asymmetric group. As stated above, compounds containing such a group may exist in three forms. The early attempts to synthesize such compounds, however, always resulted in the production of equal quantities of the dextro and levo forms, which either remained as mixtures or combined to produce the racemic form. As a result, the product obtained was always optically inactive. There is nothing remarkable in this result. Indeed, it is just what one would expect; for so far as one is able to judge the chances for the atoms to combine in one of the two possible ways is the same as the chances for them to combine in the other way. It would naturally follow, therefore, that the two possible forms of molecules will be produced in numbers that are equal, or are at least approximately so. The remarkable fact is not, therefore, that the synthetic compound of the laboratory is optically inactive or so nearly so that its activity can not be detected by any instruments yet devised, but rather that compounds occurring in nature and containing an asymmetric group with very few exceptions always occur in the active form. In other words, nature's synthetic methods result apparently in the formation of the dextro or of the levo form alone, while the synthetic methods of the laboratory always lead to the production of the two forms in equal quan-

tities. This striking difference between the natural and the laboratory synthesis has attracted much attention and extended investigations have been made in recent years to solve the mystery. Nevertheless, the problem of building up from its elements the dextro or the levo form alone or the one form in excess of the other so that the resulting product is optically active, remains to-day as in the beginning, an unsolved problem.

While the synthesis of either the dextro or the levo form alone of an asymmetric compound from its elements or from optically inactive materials has never been accomplished, nevertheless, it is entirely possible to build up an asymmetric compound if we employ another already existing optically active compound as an agent for effecting the synthesis. That such a procedure is possible was shown by Fischer in 1889 in the course of his celebrated investigations on the sugars. It had long been known that the so-called aldose sugars combine directly with hydrocyanic acid. This addition introduces a new asymmetric carbon atom into the compound:



I. II.

We might naturally expect that the two possible forms (I. and II.) of the new asymmetric group will be produced in equal amounts. Fischer found, however, that when hydrocyanic acid combines with *d*-glucose, both forms of the resulting cyanogen derivative are indeed obtained, but that the one form is obtained in excess of the other. When the action is carried on with *d*-mannose the one form only is produced. This result is readily explained upon the very reasonable assumption that the manner of the addition of the hydrocyanic acid to the sugar molecule is influenced by the forces exerted by the asymmetric groups already present in the sugar molecule. In the absence of such modifying forces, that is, in compounds which do not contain asymmetric groups, the two possible forms are produced in equal quantities, but in the presence of such asymmetric groups the two forms may be produced in unequal amounts.

Now it will readily be noticed that this observation of Fischer suggests a possible way of effecting the synthesis of an optically active body from its constituent elements. For example, if one could find some method for splitting off from the molecule, the new asymmetric carbon group added to *d*-mannose in such a way that the resulting compound would contain this asymmetric group, then it is evident that the compound so produced would be optically active since it would consist of the one form only. Thus a synthesis of an optically active compound would have been effected, although it would have been made possible through the influence of a previously existing optically active compound.

While it has not been found possible to split off the newly formed asymmetric group resulting from the addition of hydrocyanic acid to *d*-mannose, nevertheless the synthesis of a number of optically active compounds has been accomplished through the application of this general principle. Such a synthesis is generally termed an asymmetric synthesis. However, such a synthesis, accomplished as it is through the assistance of an already existing optically active compound, is only partial and I shall designate it in the discussion that follows as a partial asymmetric synthesis. This term, as I shall use it, signifies the synthesis of either the dextro or levo form alone, or of the two forms in unequal amounts, effected through the assistance of an already existing optically active compound. It is

evident, then, that the production of the two forms in equal amounts with their subsequent separation from each other—a task often easily accomplished—does not constitute a complete asymmetric synthesis.

A brief discussion of the more important attempts to effect partial asymmetric syntheses follows:

1. The first serious attempt to effect a partial asymmetric synthesis was made by Cohen and Whitely in 1901. An optically active ester was prepared by heating an unsaturated acid (mesaconic acid was used) or its derivatives with levo-menthol. The resulting ester was then reduced, whereby one of the carbon atoms present was rendered asymmetric. The ester was then saponified so that the active menthyl group was eliminated, leaving methyl succinic acid containing the newly formed asymmetric group. The course of the reactions is shown in the following equations in which the abbreviation Myl represents the menthyl group, while the newly formed asymmetric carbon atom is designated by a star:

$$\begin{array}{l} HOOC \cdot CH : CCH_3 \cdot COOH \\ \downarrow \\ MylOOC \cdot CH \cdot CCH_3 \cdot COOMyl \\ \downarrow \\ MylOOC \cdot CH_2 : \overset{*}{C}HCH_3 \cdot COOMyl \\ \downarrow \\ HOOC \cdot CH_2 : \overset{*}{C}HCH_3 \cdot COOH \end{array}$$

The resulting product, however, was inactive, showing that the dextro and levo forms had been produced in equal amounts. Pyruvic acid yielded similar results. The method selected was ingenious but did not lead to the desired end.

2. In the same year (1901) Kipping attempted to solve the problem by a method similar to that used by Cohen and Whitely. Benzoyl-formic acid was changed into an active ester by heating with borneol. The resulting ester was then reduced, whereby the carbon atom of the carbonyl group was rendered asymmetric. By hydrolysis the active bornyl radical (Byl) was removed, leaving an acid which contained the newly synthesized asymmetric group:

$$C_6H_5COCOOH \rightarrow C_6H_5COCOOByl \rightarrow C_6H_5\overset{*}{C}HOHCOOByl \rightarrow C_6H_5\overset{*}{C}HOHCOOH.$$

The results however were negative, the mandelic acid formed being inactive.

Kipping also attempted to effect a partial asymmetric synthesis through the influence of an optically active solvent. For this purpose he prepared benzoin through the action of potassium cyanide upon benzaldehyde in an alcoholic solution of camphor:

$$2\ C_6H_5CHO \rightarrow C_6H_5\overset{*}{C}HOHCOC_6H_5.$$

He likewise synthesized mandelic acid nitrile by the action of hydrocyanic acid upon benzaldehyde in an alcoholic solution of camphor; pyruvic acid and methylethylketone were reduced in a concentrated solution of grape sugar. While all of these reactions led to the synthesis of compounds containing an asymmetric group, the products in each case were inactive, showing that the two forms had been synthesized in equal quantities.

3. Two years later (1902–03) Fischer and Slimmer made another unsuccessful attempt to effect a partial asymmetric synthesis, using the optically active aldehyde, helicin, which is readily obtained from natural sources, as the active constituent for influencing the synthesis. The aldehyde group was rendered asymmetric by the addition of hydrocyanic acid as well as by the action of zinc ethyl. The resulting compounds were decomposed so that one of the products formed contained the newly synthesized asymmetric group. The products, however, proved to be inactive.

4. The first successful attempt to effect a partial asymmetric synthesis was made by Marckwald in 1904. In this investigation, brucine was used as the active agent. Marckwald started with methylethylmalonic acid. This was converted into the brucine

salt. Upon heating this salt carbon dioxide was split off, rendering the central carbon atom asymmetric. The resulting salt was treated with an acid, liberating the free methylethylacetic acid:

$$\begin{array}{l} \mathrm{HOOC \cdot CCH_3C_2H_5 \cdot COOH} \\ \downarrow \\ \mathrm{HOOC \cdot CCH_3C_2H_5 \cdot COOBrue.} \\ \downarrow \\ \mathrm{H \cdot \overset{*}{C}CH_3C_2H_5 \cdot COOBrue} \\ \downarrow \\ \mathrm{H \cdot \overset{*}{C}CH_3C_2H_5 \cdot COOH} \end{array}$$

This product was found to be slightly levo-rotatory. The results showed that while both the dextro and levo forms of the acid had been produced, there was an excess of about 16 per cent. of the levo form.

5. Following Marckwald, MacKenzie and his co-workers carried on a series of investigations in 1904, 1905, 1906, 1907, and in 1909, in which they were able to effect a number of partial asymmetric syntheses. The principal method employed by MacKenzie was very similar to that used by Kipping. An acid of the general formula R-CO-COOH was selected and changed into an optically active ester by combination with an active alcohol, such as amyl alcohol, borneol or menthol. The carbon atom of the carbonyl group was then rendered asymmetric by the action of Grignard's reagent as well as by reduction.

The resulting products, freed from the active alcohol groups, proved to be slightly active, showing that a partial asymmetric synthesis had been accomplished. A comparison of the results obtained by the use of amyl alcohol, borneol and menthol led to the conclusion that the greater the optical activity of the influencing group present, the greater is the extent of the asymmetric synthesis.

MacKenzie was also able to synthesize both dextro and levo tartaric acids in an ingenious way (1907). Fumaric acid was changed into the active bornyl or menthyl ester and this ester was then oxidized by potassium permanganate. The two central carbon atoms were thereby rendered asymmetric:

$$\begin{array}{l} \mathrm{HOOC \cdot CH : CH \cdot COOH} \\ \downarrow \\ \mathrm{BylOOC \cdot CH : CH \cdot COOByl} \\ \downarrow \\ \mathrm{BylOOC \cdot \overset{*}{C}HOH \cdot \overset{*}{C}HOH \cdot COOByl} \\ \downarrow \\ \mathrm{HOOC \cdot \overset{*}{C}HOH \cdot \overset{*}{C}HOH \cdot COOH} \end{array}$$

On saponification the resulting product yielded an optically active mixture of tartaric acids, indicating an excess of either the dextro or levo form. When menthol was used as the active agent the levo acid was in excess; when borneol was used, an excess of the dextro acid was obtained.

6. Mention should be made of the attempts to effect the synthesis of compounds containing asymmetric groups other than those of carbon. Smiles, in 1905, effected the synthesis of compounds containing asymmetric sulfur groups while E. and O. Wedekind, in 1908, built up asymmetric nitrogen groups. In neither case, however, were partial asymmetric syntheses effected. The method employed by E. and O. Wedekind was similar to that employed by Kipping in that the reactions were carried out in an optically active solvent such as *l*-menthol and *d*-limonene.

7. A distinct advance in our knowledge of asymmetric syntheses was made by Rosenthaler in 1908. Recalling the discovery of Pasteur that certain enzymes have a different action upon the dextro and levo forms of some of the sugars, Rosenthaler attempted an asymmetric synthesis by the addition of hydrocyanic acid to benzaldehyde in the presence of emulsin. By hydrolyzing the resulting compound pure levo-mandelic acid was obtained. Rosenthaler's results are especially significant; for while all the other attempts to effect partial asymmetric syntheses yielded both active forms, but with the one in slight excess of the other, Rosenthaler obtained

the one form only. It may be, however, that the reactions which Rosenthaler employed gave rise to both forms and that the dextro form was destroyed as fast as it was synthesized, through the action of the emulsin.

8. The most important contribution to the subject of asymmetric syntheses in recent years is that made by Bredig and Fiske in 1912. Bredig and Fajans had previously shown that the dextro and levo camphor-carboxylic acids decompose with different speeds in the presence of active bases. When the reaction is carried out in nicotine solution, for example, the speed of decomposition of the *d*-acid is about 13 per cent. greater than that of the *l*-acid—results that are similar to those of Dakin, who studied the hydrolysis of mandelic esters in the presence of lipase. With this information concerning the selective action of the alkaloids in mind, Bredig and Fiske attempted to utilize this property of alkaloids in effecting asymmetric syntheses. For this purpose they selected the same reaction that Rosenthaler had used, namely, the addition of hydrocyanic acid to benzaldehyde, but substituted an alkaloid for the emulsin. The results were decisive. In the presence of quinine an excess of dextro mandelic acid was formed, while quinidine gave an excess of the corresponding levo compound. The alkaloid acted as a catalytic agent since the results were obtained by the use of relatively small amounts of the bases.

While all the methods for effecting partial asymmetric syntheses so far discussed differ somewhat in detail, yet they are all fundamentally the same. In each case the object has been to bring about an asymmetric synthesis through the agency of the forces exerted by a previously existing asymmetric group. Now it is perfectly rational to suppose that in place of the forces exerted by an asymmetric group, one might utilize the forces acting in a strong magnetic field or those exerted in either plane or circularly polarized light. Accordingly, many attempts have been made to employ these agencies. Pasteur himself used the magnetic field as the active agent, as did also Boyd (1896). Meyer, in 1903, believing that the forces exerted in a magnetic field are not of the same character as those exerted by an asymmetric group, attempted to improve the experiment through the combined influence of a magnetic field and polarized light. Henle and Haakh (1908) concluded that a reaction that proceeds in the absence of light is not likely to be influenced by the action of polarized light. Accordingly they attempted to effect an asymmetric synthesis by the decomposition of certain acids of the type of malonic acid, through the action of light in the presence of uranium compounds—a reaction which will take place under the conditions of the experiment, only in the presence of light. In all of these investigations, however, no positive results were obtained.

The results of all the attempts to effect either a partial or complete asymmetric synthesis may be summed up as follows: in so far as we are able to detect with instruments at present constructed, an asymmetric compound synthesized from its constituent elements or from optically inactive compounds is always obtained in the inactive form. The optically active forms can be prepared synthetically only through the assistance of previously existing optically active compounds.

In making this general statement I am disregarding the work of Stoklosa and his co-workers (1913), who claim to have prepared optically active sugars through the action of ultra-violet light upon a mixture of carbon dioxide and hydrogen in the presence of potassium hydrogen carbonate. Stoklosa's results are of the greatest im-

portance if true, but serious doubts have been cast upon their accuracy so that they have not been at all generally accepted.

WILLIAM MCPHERSON

OHIO STATE UNIVERSITY

(*To be concluded*)

THE COMMITTEE OF ONE HUNDRED ON SCIENTIFIC RESEARCH OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE committee held its fourth meeting at the Hotel Belmont, New York City, convening shortly after two o'clock on the afternoon of December 26, 1916. Mr. Pickering was in the chair and others recorded as present were:

Raymond F. Bacon, Franz Boas, N. L. Britton, Alfred H. Brooks, Ernest W. Brown, Walter B. Cannon, J. J. Carty, J. McK. Cattell, C. R. Cross, Chas. B. Davenport, W. M. Davis, Henry H. Donaldson, H. L. Fairchild, Irving Hardesty, G. Ross Harrison, L. O. Howard, Aleš Hrdlička, W. J. Humphreys, Edward Kasner, A. E. Kennelly, Irving Langmuir, Berthold Laufer, Frederic S. Lee, Jacques Loeb, D. T. MacDougal, J. C. Merriam, G. A. Miller, T. H. Morgan, H. V. Neal, Edw. L. Nichols, A. A. Noyes, Richard M. Pearce, M. I. Pupin, Jos. W. Richards, F. K. Richtmyer, Peyton Rous, H. N. Russell, Frank Schlesinger, Geo. Otis Smith, J. Stieglitz, Chas. R. Stockard, E. L. Thorndike, A. M. Tozzer, Charles R. Van Hise, John B. Watson, A. G. Webster, David White, W. R. Whitney, Edmund B. Wilson, W. M. Wheeler, R. M. Yerkes.

After introductory remarks by the chairman, the secretary reported that, since the organization of the committee at Atlanta four years ago, it had lost by death: Charles E. Bessey, professor of botany, University of Nebraska; Theodore Gill, professor of zoology, George Washington University; Karl E. Guthe, professor of physics, University of Michigan; Joseph A. Holmes, chief of the Bureau of Mines, Washington, D. C.; Charles S. Minot, professor of comparative anatomy, Harvard Medical School, and F. W. Putnam, professor emeritus of anthropology, Harvard University. There had been added to the committee: Raymond F. Bacon, director of the Mellon Institute for Industrial Research, the University of Pittsburgh; W. B. Cannon, professor of physiology, Harvard Medical School, and John C. Merriam, professor of paleontology, the University of California.

Since the meeting last year at Columbus the following subcommittees in different sciences had been appointed:

Mathematics: G. A. Miller, *Chairman*, Edward Kasner, E. H. Moore, W. F. Osgood, E. B. Van Vleck.

Astronomy: Edward C. Pickering, *Chairman*, E. W. Brown, E. B. Frost, H. N. Russell, F. Schlesinger.

Physics: Arthur G. Webster, *Chairman*, C. E. Mendenhall, Ernest Merritt, R. A. Millikan, M. I. Pupin.

Chemistry: Julius Stieglitz, *Chairman*, I. Langmuir, G. N. Lewis, W. A. Noyes, T. W. Richards.

Engineering: A. E. Kennelly, *Chairman*, J. W. Richards, A. Sauveur, A. N. Talbot, C. C. Thomas.

Geology and Geography: Wm. M. Davis, *Chairman*, Alfred H. Brooks, L. C. Glenn, C. K. Leith, Bailey Willis.

Botany: George T. Moore, *Chairman*, D. H. Campbell, R. A. Harper, L. R. Jones, B. E. Livingston.

Zoology: Edwin G. Conklin, *Chairman*, F. R. Lillie, T. H. Morgan, G. H. Parker, Jacob Reighard.

Anatomy: Ross G. Harrison, *Chairman*, F. P. Mall, C. R. Stockard, C. M. Jackson, Irving Hardesty.

Pathology: Richard M. Pearce, *Chairman*, Theodore C. Janeway, Eugene L. Opie, Peyton Rous, H. Gideon Wells.

Physiology: W. B. Cannon, *Chairman*, Joseph Erlanger, Theodore Hough, Frederic S. Lee, Walter J. Meek.

Psychology: J. McKeen Cattell, *Chairman*, C. E. Seashore, E. L. Thorndike, John B. Watson, Robert M. Yerkes.

Anthropology: Franz Boas, *Chairman*, A. Hrdlicka, Alfred L. Kroeber, Berthold Laufer, Alfred M. Tozzer.

Reports were presented by the chairmen of nearly all the subcommittees. The report of the subcommittee on industrial research, presented by Mr. Bacon, was a special order, and by invitation was discussed by Mr. J. J. Carty, chairman of a committee of similar scope of the National Research Council and by Mr. F. K. Richtmyer, secretary of a corresponding committee of the American Physical Society.

This report, which was further discussed by several members, was printed in the issue of SCIENCE for January 5.

Other reports were presented, as follows:

Research on the Pacific Coast: Mr. Merrian.
Research Funds: Mr. Cross.
The Training of Students for Research: Mr. Brown.
Mathematics: Mr. Miller.
Astronomy: Mr. Pickering.
Physics: Mr. Webster.
Chemistry: Mr. Stieglitz.
Engineering: Mr. Kennelly.
Geology and Geography: Mr. Davis.
Zoology: Mr. Conklin.
Anatomy: Mr. Harrison.
Pathology: Mr. Pearce.
Physiology: Mr. Cannon.
Psychology: Mr. Cattell.
Anthropology: Mr. Boas.

The reports of the chairmen of the subcommittees were in most cases preliminary. They were discussed by various members. Those containing definite results or recommendations will be printed.

It was reported to the committee that, at the request of the National Research Council, the Committee on Policy of the American Association for the Advancement of Science had authorized the appointment by the president of the association of a committee on cooperation to include himself. The other members appointed by the president were: Mr. Nichols, chairman of the Committee on Policy, and Mr. Howard, permanent secretary of the association. Mr. Nichols and Mr. Howard had met in New York with Mr. Noyes and Mr. Conklin, representing the National Research Council, and took the following action:

The Committee on Cooperation recommends (1) that the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science cooperate with the National Research Council in those research movements in which both organizations are interested and especially in order to avoid duplication of effort that might arise from individual action of the two groups of committees which have already been appointed in the different sciences; (2) that the Committee of One Hundred, of the Association, cooperate with the National Academy of Sciences and the national scientific societies in the formation of single committees in the various branches of science, with the understanding that the present members of the association committees will become members of these committees of the National Research Council.

On motion of Mr. Noyes, this action was approved, except the final clause "with the understanding that the present members of the association committees will become members of these committees of the National Research Council." Mr. Noyes moved that:

In order to effect the cooperation provided by the preceding vote, the Committee of One Hundred on Research designate through its chairman members of the association to serve as members of the research committees of the National Research Council devoted to the various branches of science, with the understanding that those committees will consist of members designated in equal or approximately equal numbers by the association, the National Academy of Sciences, and the national scientific society representing the branch of research involved.

After discussion this motion was carried.

On motion of Mr. Boas, a subcommittee was authorized on cooperation between municipalities and incorporated institutions engaged in research.

The committee adjourned shortly after five o'clock to meet at two o'clock on the afternoon of the first day of the next annual meeting of the association, which will be on December 28, at Pittsburgh, Pa.

J. McKEEN CATTELL,
Secretary

SCIENTIFIC EVENTS

CONGRESS ON MEDICAL EDUCATION, PUBLIC HEALTH AND MEDICAL LICENSURE

THE next Congress on Medical Education, Public Health and Medical Licensure, participated in by the Councils on Medical Education and on Health and Public Instruction of the American Medical Association, the Federation of State Medical Boards of the United States and the Association of American Medical Colleges, will be held at the Congress Hotel, Chicago, on February 5 and 6, 1917. According to the *Journal* of the American Medical Association the program of Monday morning, February 5, will be on medical education. The program follows:

Opening of the Conference, Dr. Arthur Dean Bevan, chairman of the council on medical education, Chicago.

"Progress of the Year in Medical Education," Dr. N. P. Colwell, secretary of the Council on Medical Education, Chicago.

"The Problem of Higher Degrees in Medicine," Dr. Horace D. Arnold, dean, Harvard Graduate School of Medicine, Boston.

Symposium: "Economy of Time in Preliminary and Medical Education." Dr. John L. Heffron, president of the Association of American Medical Colleges, Syracuse, N. Y. Hon. P. P. Claxton, United States Commissioner of Education, Washington, D. C. President Harry Pratt Judson, University of Chicago. Discussion by President George E. Vincent, of the University of Minnesota, Minneapolis, and Professor C. H. Judd, University of Chicago.

On Monday afternoon the general topic will be medical licensure. The program follows:

"Practical Examinations by State Licensing Boards," by Dr. Walter P. Bowers, Secretary of the Massachusetts Board of Registration in Medicine, Boston.

"Minnesota Practical Examinations—As They Are and As We Should Like to Have Them," Dr. Annah Hurd, member of the Minnesota State Board of Medical Examiners, Minneapolis.

Discussion opened by Dr. W. J. Means, chairman, Executive Council, Association of American Medical Colleges, Columbus, Ohio.

Report of Examination Held by the National Board of Medical Examiners, Dr. Isadore Dyer, a member of the National Board and Dean of the Tulane University of Louisiana School of Medicine, New Orleans.

Discussion opened by Dr. John M. Baldy, president, Pennsylvania Bureau of Medical Education and Licensure, Philadelphia.

"The Problem of the Medical Cults," Dr. David A. Strickler, president of the Federation of State Medical Boards and secretary of the Colorado State Board of Medical Examiners, Denver.

Discussion opened by Mr. Harry E. Kelly, formerly attorney for the Colorado State Board of Medical Examiners, Chicago.

On Tuesday morning public health topics will be discussed. The program follows:

Opening of the Conference, Dr. Frank Billings, chairman of the Council on Health and Public Instruction, Chicago.

"Public Health Training in Medical Colleges," Dr. George E. Vincent, president, University of Minnesota, and president-elect, Rockefeller Foundation.

"What Training Should the Public Health Officer Receive in Medical Colleges," Dr. Hermann E. Biggs, state commissioner of health, New York.

Discussion opened by Dr. Victor C. Vaughan and Dr. S. J. Crumbine.

On Tuesday afternoon there will be a popular discussion of topics relating to medical licensure. The program follows:

"State Regulation of the Practise of Medicine an Educational Problem," Professor Edmund J. James, president, Illinois State University.

"The State Regulation of the Practise of Medicine as an Executive Problem," Honorable James M. Cox, *governor* of Ohio.

Discussion opened by Dr. C. St. Clair Drake, Dr. W. B. Hinsdale and Dr. William P. Best.

ADDRESSES AND LECTURES

AT the thirteenth annual meeting of the Association of American Geographers held in New York, a symposium on "The Geography of the War," was conducted by Professor Douglas Wilson Johnson, of Columbia University, the program being as follows:

INTRODUCTION

"The Geographic Factor in Military Problems," by Douglas W. Johnson.

THE WAR ON LAND

"The Plains of Northern France," by Sumner W. Cushing.

"Rivers and Marshes of the Eastern Front," by Lawrence Martin.

"The Danube Valley and the Balkan Complex," by Ellsworth Huntington.

"The Carpathian Mountains and Transylvanian Alps," by Emmanuel De Martonne.

THE WAR ON WATER

"Geographic Aspects of the War on Water," by J. Paul Goode.

THE WAR IN THE AIR

"Geographic Aspects of the War in the Air," by R. DeC. Ward.

ECONOMIC EFFECT OF THE WAR

"Economic Geography of the War," by J. Russell Smith.

DR. S. W. WILLISTON, of the University of Chicago, gave a lecture on "The Earliest

Known Air-breathing Vertebrates" under the auspices of the Science Club of the University of Wisconsin on December 16, 1916. Among future lecturers are the following:

Dr. E. C. Rosenow, of the Mayo Foundation, on "The Etiology of Epidemic Poliomyelitis," on January 12, 1917.

Professor Robert DeC. Ward, of Harvard University, on "The Weather and the War," on January 19, 1917.

Dr. Frederic S. Lee, of Columbia University, on a subject yet to be announced, on February 12, 1917.

Professor G. A. Miller, of the University of Illinois, on "The Function of Mathematics in Scientific Research."

Professor C. S. Slichter, of the University of Wisconsin, on "Science at the University of Alexandria."

A course of six lectures on psychopathology is being given by Dr. E. E. Southard, professor of neuropathology in the Harvard Medical School, before the department of psychology, Columbia University. The lectures given at four o'clock, in Schermerhorn Hall, are:

Tuesday, January 2, "Neuropathology and Psychopathology."

Wednesday, January 3, "The Brains of the Feeble-Minded."

Wednesday, January 31, "Frontal Lobe Functions."

Thursday, February 1, "The Analysis of Delusions."

Thursday, February 8, "The Unconscious."

Friday, February 9, "Psychopathia."

The following program of lectures is offered for this season by the Ottawa Field Naturalists Club:

December 16, "A Journey through Space," by Dr. J. S. Plaskett, Dominion Observatory, Ottawa.

January 9, "Are Our Forests Vanishing—What Are We Doing to Perpetuate Them"? by Mr. R. N. Campbell, director of forestry, Ottawa.

January 23, "Our Winter Birds," by Dr. N. Y. Williams, Geological Survey, Ottawa.

February 6, "The Animals of Arctic Canada," by Dr. R. M. Anderson, lately in charge of southern scientific party of Canadian Arctic Expedition.

February 20, "Fishes and the Fishing Industry," by Mr. Andrew Halkett, naturalist, Naval Department, Ottawa.

March 6, "The Conservation of Wild Life in Canada," by Dr. C. Gordon Hewitt, Dominion Entomologist, Ottawa.

March 20. Annual meeting. Presidential address: "Recent Archeological Work in Canada," by Mr. Harlan I. Smith, Geological Survey, Ottawa.

A SCHOOL OF FISHERIES AT THE UNIVERSITY OF WASHINGTON

A school of fisheries will be established at the University of Washington within the next two years, if the appropriation bill for the university is passed as it now stands. The need for scientific study of fishing problems is already felt to so great an extent that Professors Kincaid and E. Victor Smith, of the biology department, are devoting much time to the scientific phases of the industry. Professor Kincaid is investigating and fostering the oyster industry on the Pacific coast and Professor Smith is studying salmon and salmon hatcheries, particularly.

The passage of the required appropriation by the legislature will make possible the addition of an expert authority on fishing and fisheries, the addition of laboratory equipment, the enlargement of the scope of the university and the addition of increased laboratory space to handle problems that arise through study.

The university, in connection with the Seattle Port Commission, has invited the *Albatross*, the official ship maintained by the United States Bureau of Fisheries for the scientific investigation of the fishing industry, to winter in the fresh waters of Lake Union, which wash one edge of the campus. Plans are being considered that may make the *Albatross* available for students and instructors. The ship works with a crew of seventy men and three experts and centers its activity in the North Pacific Ocean. At present it is investigating tuna fishing off the coast of southern California. If the *Albatross* is made available for students and professors, particularly those interested directly in the fishing industry, it will serve as a practical laboratory wherein can be solved the problems that are confronting the industry along the Pacific seaboard.

SCIENTIFIC NOTES AND NEWS

PROFESSOR REID HUNT, of the Harvard Medical School, has been elected president of the American Society of Pharmacology and Experimental Therapeutics.

AT the fifteenth annual meeting of the American Anthropological Association held in New York, from December 26 to 29, officers for the ensuing year were elected as follows: *President,* Alfred L. Kroeber, Affiliated Colleges, San Francisco; *Secretary,* Alfred M. Tozzer, Harvard University; *Treasurer,* Neil M. Judd, U. S. National Museum; *Editor,* Pliny E. Goddard, American Museum of Natural History.

AT the recent thirtieth anniversary celebration of the Michigan College of Mines, Dr. M. E. Wadsworth, the first president of the college, now emeritus dean and professor of mining geology in the school of mines of the University of Pittsburgh, gave the address, his subject being "The Michigan College of Mines in the Nineteenth Century."

AT the meeting of the Philosophical Society of Washington on January 20, the retiring president, Dr. Lyman J. Briggs, will give the address on "The Living Plant as a Physical System."

THE Society of Chemical Industry has awarded the Perkins medal to Dr. Ernst Twitchell. The presentation will be made by Dr. Charles F. Chandler on the evening of January 19. It will be followed by addresses by Dr. A. C. Langmuir on "The Twitchell Process in the Glycerin Trade," and by Martin H. Ittner on "The Twitchell Process in the Soap and Candle Industry."

ACCORDING to the *Journal* of the American Medical Association, the Alvarenga prize, awarded annually by the Swedish Medical Association, has for 1916 been given to Dr. E. Nilsson for his comprehensive study of the physical development and fitness for military service of the young men of Sweden between 1861 and 1913. The association distributed eleven other prizes. The jubilee prize was given to H. B. Lundborg for his medical-biologic study of generations of certain families in Sweden totaling 2,232 members. He traced the working of the Mendelian laws of heredity through nearly 200 years.

PROFESSOR S. A. FORBES, of the department of entomology of the University of Illinois, has been called to Washington, D. C., to consult with the members of the United States Bureau of Entomology, in regard to formulating plans for a campaign against the Hessian fly, of which Professor Forbes has made a study.

DR. F. R. WATSON, of the department of physics of the University of Illinois, who has made several years' research on the subject of acoustics, is being consulted by the United States navy officials concerning the acoustical conditions necessary for sound-proof radio rooms on battleships. It has become highly important that the wireless operator on a battleship be able to receive messages without interruption by outside noises, and the Navy Department is searching for a sound-proof room where the operator can work without interference.

NORTHWESTERN UNIVERSITY has appointed a local committee to cooperate with the National Research Council in its service for the United States government. The committee is composed of the following persons: *For the board of trustees,* Messrs. James A. Patten, Irwin C. Rew, William S. Mason, Theodore W. Robinson. *For the alumni,* Dr. Chas. H. Mayo, Rochester, Minn., Dr. W. E. Danforth, Evanston, Ill. *For the faculty,* Professors Henry Crew, D. R. Curtiss, Ulysses S. Grant, Philip Fox and William A. Locy, of the College of Liberal Arts; Professors A. B. Kanavel, A. I. Kendall, J. H. Long and S. W. Ranson, of the Medical School; Professor John H. Wigmore, of the Law School; Professor O. H. Basquin, of the College of Engineering; and Professors Arthur D. Black and Thomas L. Gilmer, of the Dental School.

THE *Aurora,* under the command of Captain Davis, sailed from Port Chalmers, New Zealand, for the Antarctic on December, with Sir Ernest Shackleton on board. Sir Ernest will command the land operations for relief of the

members of the expedition marooned in Ross Sea, and is hopeful of finding Lieutenant Macintosh's party well. Before the departure of the *Aurora* a civic reception was given at Dunedin in honor of Sir Ernest Shackleton, who arrived there in company with Dr. R. McNab, minister of marine.

Dr. Barton Warren Evermann, of the Museum of the California Academy of Sciences, spent a portion of December in the east. He represented the academy as a delegate at the dedication of the new building of ceramics at the University of Illinois. At the annual meeting of the Indiana Academy of Science at Indianapolis, on December 8 and 9, which was devoted chiefly to papers dealing with a century of science in Indiana, he presented a paper on "A Century of Zoology in Indiana." At a meeting of the Washington Biological Society Dr. Evermann spoke on the work the California Academy of Sciences is doing in the installation of habitat groups, illustrating his remarks with colored slides. The same address was given at Butler University.

Professor R. A. Millikan, of the University of Chicago, will give on the Hitchcock Foundation at the University of California, the following lectures:

"Electricity in the Nineteenth Century."

"X-rays and the Birth of the New Physics."

"The Electron—Its Isolation and Measurement."

"Brownian Movements and Sub-electrons."

"The Structure of the Atom."

"The Nature of Radiation."

Professor E. P. Lewis, of the University of California, recently lectured at the State University of Iowa on the following subjects: "The Multiple States of Nitrogen as Indicated by Its Spectra," "The Spectroscopic Exploration of the Heavens," and "The Electrical Properties of Flames."

Dr. Lewellys F. Barker, of the Johns Hopkins University, delivered an address on "Internal Secretions," before the Medical Society of the City and County of Denver, on December 26.

At the stated meeting of the Geographic Society of Chicago on January 12, Professor Emmanuel de Martonne, associate professor of geography, of the University of Paris, gave an illustrated lecture entitled, "The Battle Fields of France."

John Finlayson, an explorer, for whom Finlayson River and Finlayson Lake in Yukon territory were named, died on January 8, aged one hundred and five years. Finlayson, who was a native of Scotland, prospected and mined gold in California and Oregon until he was eighty-six years old and then went to British Columbia and Yukon territory, where he explored large areas in which white men had never penetrated.

Mr. Daniel Oliver, F.R.S., died on December 23, at his residence at Kew, in his eighty-seventh year. He was professor of botany at University College, London, from 1861 to 1888, and afterwards keeper of the herbarium and library at Kew Gardens.

Mr. F. W. Levander, editor of the *Journal* and *Memoirs* of the British Astronomical Association, died on December 20, aged seventy-seven years.

Professor Jean Baptiste A. Chauveau, the eminent biologist, member of the Section of Agriculture of the French Academy of Sciences and of the Academy of Medicine, died on January 4, in Paris.

The manuscript for a report on "The Peat Deposits of Connecticut" was in the hands of Dr. Charles A. Davis, of the Bureau of Mines, at the time of his death. Careful search has failed to locate this manuscript. It is possible that it had been sent for criticism to some scientific worker and had not been returned. Any one who has knowledge regarding this manuscript is requested to address Professor Herbert E. Gregory, Yale University, New Haven, Conn.

At the first session of the American Congress on Internal Medicine, held in New York on December 28 and 29, there was founded the new American College of Physicians, and sixty-five physicians were given fellowships, the selection having been made by the council of the congress.

MESSRS. JOHN WILEY AND SONS, INCORPORATED, write that they supply filing-card announcements of their new books covering scientific and technical subjects, in accordance with the plan recommended by Mr. Wilhelm Segerblom in the issue of SCIENCE for January 5. They will send copies of these cards to those who may be interested.

UNIVERSITY AND EDUCATIONAL NEWS

THE Billings family of Chicago, headed by Mr. C. K. G. Billings, has given one million dollars to the University of Chicago toward the endowment of the medical school. The money is to be used to provide a hospital in connection with the school.

THE late Mr. John D. Archbold has bequeathed the sum of $500,000 to Syracuse University.

MR. JACOB H. SCHIFF has given the sum of $50,000 to New York University toward the fund of $300,000 for the division of public affairs in the school of commerce.

THE alumni of Harvard University plan to collect a fund of ten million dollars for the permanent endowment fund of the university.

PROFESSOR A. A. NOYES, director of the research laboratory of physical chemistry at the Massachusetts Institute of Technology, will spend the next five months at Throop College, Pasadena, Cal., where the new chemistry building will be occupied about February 1.

DR. ROSWELL ANGIER, assistant professor of psychology at Yale University, will during the second half year give at Yale University one of the courses given by the late Hugo Münsterberg. The other courses will be given by Assistant Professor H. S. Langfeld and Dr. L. T. Troland.

THE *Journal* of the American Medical Association states that the senate of Queen's University, Kingston, Ont., has issued a memorandum covering its objections to the action of the University of Toronto in deciding to establish in 1918 a six-year academic course in medicine. A conference had been held between representatives of the two universities but no other universities interested in Canada had been asked to participate in that conference. Queen's University says that the proposals come at a time when there is an unusual demand for the services of medical men from the British and Canadian governments, and that the great need for medical men will not immediately cease when the war is over.

DISCUSSION AND CORRESPONDENCE

THE INFLUENCE OF DISEASE IN THE EXTINCTION OF RACES

OSBORN[1] has called our attention to the part disease may have played in the extinction of certain mammalian groups especially. He based his suggestion on the prevalence of certain diseases among modern mammals, such as Texas fever, "rinderpest," biliary fever and the disease transmitted by the tse-tse fly. He says:

> Thus in these diseases we have all the conditions favorable for the wide distribution of insect-borne diseases which in past times may have attacked various types of quadrupeds and resulted in extermination before natural immunity was acquired.

He did not, however, cite any instances in which disease is known to have played a part among the fossil vertebrates, and it is not likely that epidemic diseases of which he spoke should leave an impress on the skeleton.

The writer[2] has already indicated how a study of pathological lesions on fossil bones may show something of the widespread nature of disease in geological time. During the past few months there have been accumulated evidences of at least a score of diseases which are suggested by the lesions found on the petrified skeletal remains. Since the detailed description of these will appear elsewhere, it will only be necessary to say here that disease, as indicated by the above-mentioned lesions, was widespread quite early in the history of the early vertebrates. Pathological bones have so far not been noted in the early or

[1] H. F. Osborn, *American Naturalist,* Vol. XL., p. 836, 1906.

[2] SCIENCE, N. S., Vol. XLIII., No. 1108, pp. 425–426, 1916. *American Journal of Science,* Vol. XLI., pp. 530–531, 1916.

middle Paleozoic, but in the Permian diseased bones have been described by Renault, which were afflicted with caries, and he was able to discern something of the nature of the bacteria producing these lesions. Walcott[3] has indicated the presence of bacteria in a much earlier period but, so far as I am aware, nothing of the diseased nature of fossil forms is known earlier than that stated above.

The lesions so far studied are the results of accidents, or of infections and none of them are very extensive. It is improbable that any of the lesions so far studied were so severe that the life of the individual afflicted was endangered. Certainly none of them are severe enough to have endangered the race. Troxell[4] has suggested in the description of a pathologic camel phalanx from the Pleistocene of Texas:

> The interesting pathologic phalanx is probably a result of exostosis or uncontrolled deposition of bony material. The bone was not broken, because it shows the same length as the normal one of the same size. Possibly the disease which caused the death of the individual also contributed to the destruction of the species.

It is to be doubted if lesions of this nature are ever fatal. They may result in the loss of usefulness of the member afflicted and in the case of the camel, aside from a stiffness in the foot afflicted, probably no other result was noticeable. Troxell has mentioned that the introduction of swampy conditions into that region was instrumental in the extinction of the fauna, and it is to be further noted that the swampy condition also produced the arthritic lesion in the camel phalanx, since arthritides are more commonly found in animals inhabiting moist places, and are particularly severe in extinct cave-inhabiting and fossorial animals.

It is not my intention to contend that disease has not been influential in the extinction of races; it probably has been; but those diseases which have left an impress on the fossilized skeleton certainly can not be regarded as among those diseases which would produce widespread extinction. Some other has been the dominant factor. Among the labyrinthodonts, for instance, there is no evidence of disease on the skeletons, and we know that after a sudden rise and world-wide distribution of species, suddenly the whole group went out of existence. The same may be said of other early groups of vertebrates. The present results of the study of fossil pathology indicate the early appearance in geological time and widespread distribution of diseases of many kinds, but none of them, so far as these lesions may be interpreted, were sufficiently severe to have played a part in the extinction of any of the known races of vertebrates. They are to be regarded rather as chronic infectious or constitutional diseases which may have played a part in extinction, but there must have been some other and more powerful ally which is at present unknown.

[3] C. D. Walcott, 1915, *Proc. Natl. Acad. Sci.*, April, 1915, pp. 256–257.

[4] E. L. Troxell, 1915, *Amer. Journ. Sci.*, Vol. XXXIX., p. 626, Fig. 14.

Roy L. Moodie

University of Illinois,
College of Medicine,
Chicago

VERTICAL FILING FOR PAMPHLET COLLECTIONS

In the issue of Science for November 24 Professor Storer calls attention to the important matter of properly caring for pamphlet collections. He also brings together in very serviceable form the data regarding the various methods which have been used in storing pamphlets. The writer merely wishes to add some items from his experience in using for this purpose ordinary commercial vertical filing cases.

When this system is used the pamphlets are placed in the drawers of the cabinet face forward and with the back of the pamphlet uppermost. It is thus possible to read the back title if the pamphlet bears one, or to separate the pamphlets slightly as one would cards in a card index and thus note the title printed or written on the front cover. Guides are inserted at convenient intervals to assist in finding the particular group of pamphlets desired. These guides may provide a series of

subdivisions as minute as desired, though in practise an average of one guide per inch will be found to be a generous allowance. Any pamphlet in the series may be found and removed without disturbing others, or the whole group bearing upon a single subject may be located instantly.

It goes without saying that the publications are protected in the most complete manner from dust, light and accidental injury and are at the same time kept perfectly flat and under light pressure.

The total floor space occupied is little if any greater than is required for storage on shelves. The horizontal extent of the case along the wall is less than in other types of storage. The latter point is often of great importance, due to the limited amount of wall space in many offices. Furthermore, the vertical file may be placed in the center of the floor if the room happens to be a large one. The entire cabinet with its contents can be moved from one location to another with no risk of disarranging the collection.

Storage in this manner is not as expensive as is ordinarily supposed. A vertical filing case which I have just received for my own use contains filing space equal to 110 inches of shelving. The cost is about twelve and one half cents per inch, without guides. This is not a transfer case, but a well-made five-drawer upright unit, invoice size. It is steel construction inside with oak exterior. Data are not at hand regarding the cost of filing in pamphlet cases, but shelving with closed dust-proof back if made of selected lumber and well finished would cost probably from seven to ten cents per lineal inch of filing space. If to this be added the cost of pamphlet cases the expense of the method can not be much less than that of vertical filing. The convenience of the latter is such that it would appear advisable to investigate it closely in every case before adopting another system. It offers particular advantages for personal use.

It should be added that the file that I am using accommodates papers with a greatest dimension of ten and one fourth inches. This will provide for most separates, though there are of course a few which are too large. Larger drawers will cost about the same per cubic inch, but correspondingly more per lineal inch.

W. L. EIKENBERRY

SCHOOL OF EDUCATION,
UNIVERSITY OF KANSAS

PHRENOLOGY

IT is gratifying to report the receipt of the following communication, relating to the lecture on "Phrenology" which was referred to in SCIENCE of December 29. The letter is dated January 4, and is signed by Professor Wm. A. Wilbur, dean of Columbian College, George Washington University.

Following your letters of December 21 and December 23, concerning an announced lecture on phrenology before the Enosinian Society, and following a letter of December 26 from Dr. Frank Baker, relating to the same subject, President Stockton directed me to see that the lecture was not given. On December 28 I notified the president of the society of President Stockton's directions in the matter, and I am in receipt from him of a letter of January 3 cancelling all arrangements for the lecture referred to.

President Stockton directed me to say that he felt sure you would wish to give this action of the university as wide publicity as the announcement and note over your signature in the issue of SCIENCE of December 29, 1916.

A. HRDLICKA

U. S. NATIONAL MUSEUM,
WASHINGTON, D. C.

QUOTATIONS

THE TEACHING OF SCIENCE IN GREAT BRITAIN

WHILE discussion is in progress as to the right principles upon which science, now beginning to be recognized as an educational essential, should be introduced into our curricula, it is well to wait until some general synthesis of opinion has been effected before attempting a general summary of conclusions. In practise, we shall arrive at the type of science teaching that commends itself to those who are most closely in contact with present needs and conditions. But it may help to clear the air of controversy if two points of view are restated which are coming into gen-

ral recognition, the one as a result of educational thought before the war, the other in connection with the wide upheaval of opinion that the war has caused.

In December, 1912, we published a draft scheme for the teaching of science upon a synthetic method—the term "synthetic," in this case, implying that science was to be taught as a whole in the more elementary stages, with the rudiments of the separate, specialized sciences blended together and taught in connection with one another as parts of a single realization. The sciences were in danger of becoming the monopoly of specialists; not a mere financial monopoly. but a monopoly of faculty and intelligence. In a civilization increasingly governed by science, it seemed to us of importance that citizens should have a general comprehension of science. More than this: specialists themselves go wrong if they never fully realize the broad foundations of their specialties. A narrow specialist is a bad specialist. The more important specialism in science was destined to become, the more essential we felt it to be that a wide general conception of science should be taught; not only that people might have some conception of the scientific principles upon which they were increasingly governed, but also that the specialists of the future might have a broader foundation for their work through a better realization of the dependence of one branch of science upon the others.

The war has taught us by force what we might not, perhaps, have learned so rapidly by the peaceful exercise of our wits: that in national endeavor all branches of activity must be subordinated to a conception of the whole. The present demand for more science comes of a recognition that, for all our special excellences, our general ignorance of causes had come near to destroying us. And with this recognition there comes a conception of science that goes beyond a synthesis of "the sciences." The scientific outlook, the scientific method, call for a place not only in science teaching, but in all teaching. This is not because we admire German scientific organization. As a matter of pure science, we detest German scientific organization because it is fundamentally unscientific, just as it is fundamentally inhuman. It favors prejudices, not truths. We want to put a right scientific organization in its place; we have seen the results of having no scientific organization at all, though we have battled against these evil results with extraordinarily rapid success.

The war is teaching us a new science of our own and a new humanism of our own. Both are in embryo, as far as education is concerned; much thought and discussion are still needed for the further evolution of a complete system. But one thing becomes increasingly clear. There is no war between our new science and our new humanism. The dying quarrel lies between prejudices rather than between principles. We need a science teaching that is complete and unified; but by now we are coming to realize that we also need a humanistic science, and a humanism that is scientific. Such a solution, if we take the pains to work it out, will be thoroughly in accord with the English genius.—*London Times Educational Supplement.*

SCIENTIFIC BOOKS

Bridge Engineering. By J. A. L. WADDELL. John Wiley and Sons, New York, 1916. 2 Vols. 2177 pp.

Like most branches of science or of engineering, the field of structural engineering is abundantly supplied with text-books and treatises. However, as in a vocation there is always room at the top, so in the literature of a subject there is always room for a new work if it presents the subject from a fresh point of view, or if it contributes something new, or puts in a new light something which may be a matter of even common knowledge.

In engineering there is always opportunity for a contribution which will be of value if it embodies results of experience, even upon subjects of which the fundamental principles are well understood, for engineering deals with the applications of science, and, in those applications, conditions are so available that, as is well known, good judgment, common sense and

the ability to meet emergencies are more important requisites for success than deep or accurate scientific knowledge.

The author of the work under review is not only possessed of deep and accurate scientific knowledge, but has had an exceptionally wide and valuable experience as an engineer. The present work is not an ordinary text-book; indeed most of the subjects discussed in ordinary text-books are entirely omitted here. This work begins, broadly speaking, where the usual text-book leaves off, and concerns itself with an exhaustive discussion ranging from large questions down to details of design, and throughout it all the author draws upon his experience, and, in an easy conversational way which makes the book very readable, places here on record his opinions, his deductions, and his experiences regarding most of the important matters involved in the design of bridge structures.

The work is a large one, comprising two bulky volumes, with a total of over two thousand pages. Indeed, if any criticism is to be made of the work, it is that it is too bulky and includes some information which might well have been omitted, such for instance, as a glossary of terms covering 220 pages which might have been relegated to a technical dictionary rather than included in a treatise on bridge engineering. However, the book, as stated, is not a text-book, and will not be carried about by college students in their grips; it is a reference book for the office and for the consulting engineer, and for such it will be found of great value. The bridge engineer who desires to inform himself with reference to any type of structure, or to investigate any particular problem, will be apt to find in this work some clue which will guide him, if indeed he does not find the direct answer to his inquiry.

The book is rather uneven, it is true, in its treatment, devoting for instance, forty-eight pages to the subject of cantilever bridges, thirty pages to arches of all the various kinds, sixteen pages to suspension bridges, and seven pages to wooden bridges and trestles. However, the work does not pretend to be a complete treatise; it is supplementary to the usual text-books and the author has not thought it necessary or desirable, merely for the sake of completeness, to cover ground which is quite adequately treated in other works. This work is supplementary to such treatises and aims to give the profession the results of the experience and study of its author, and the opinions which he has been led to hold on the various matters of bridge design and construction. It will be found a very valuable work for the consulting engineer and the bridge specialist, while the engineering student will find an opportunity therein to pursue lines of inquiry upon which he may be engaged, and to learn the opinions of an eminent bridge engineer.

A characteristic of the work is the inclusion therein of a number of chapters relating to matters not generally touched upon in such works, such, for instance, as "Esthetics in Design," "Office Practise," "Bridge Failures and Their Lessons," "Responsibility of the Bridge Engineer," "Ethics of Bridge Engineering." A very interesting chapter is that on "Expedients in Design and Construction" in which instances are give of the exercise of the important quality of "gumption" which every successful engineer must possess in greater or less degree. The book will be found of value, not only for the technical information which it contains, but because it emphasizes the necessity for qualities, other than mere mathematical ability or an understanding of small technical details, for the successful structural engineer. It is a book which will tend to broaden the view and so increase the usefulness of the young engineer.

GEORGE F. SWAIN
HARVARD UNIVERSITY AND THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SPECIAL ARTICLES

ON THE ELECTRIC ORGANS OF GYMNOTUS CARAPUS

IT was suggested to the writer by Professor U. Dahlgren, of Princeton University, that *Gymnotus carapus* might furnish material for the study of electric organs. Miss A. Lowrey[1]

[1] *Jour. Morph.*, Vol. 24, p. 693.

in her examination of several Gymnotid fishes was unable to find electric tissues. She found that

> in or between the first and second muscular units of the ventral portion of the great lateral muscles, there was a slight degeneration of parts of the muscles. The larger units had been reduced to two minute oval muscles embedded in either strands of cartilage, or strands of cartilage and fat, and occupied parts of two triangular spaces, one on each side of the median septum just above the (muscle) unit which controls the anal fin. No plates, special nerve fibers, or nerve endings were seen.

In my examination of the specimen which had been collected by Professor Dahlgren some years ago, I noticed that when the fish was scaled a portion of the body appeared almost translucent. The location of this part corresponds exactly to the location described by Miss Lowrey where "slight degeneration of parts of the muscles" had taken place. Sections were made of this portion of the body, and a study of these has shown beyond all doubt that the portion of the body in question is composed of electric tissue. Not only were the characteristic electroplaxes found, but also the special electric nerve fibers and blood-vessels supplying them.

The fish used for this study measured approximately 31 cm. in length. The body is more or less filiform, tapering to an extremely finely pointed tail. The head is flattened dorsally and the upper lip projects slightly over the lower lip. The gill opening is rather small with a dusky spot just above it. The vent opens just behind the throat. The dorsal fin is entirely lacking, while the ventral fin extends from the tip of the finely pointed tail to a position just posterior to the vent opening. The fin is controlled by a muscle unit lying just dorsal to it. The electric organs extend from the tip of the tail forward, following along the entire length of the ventral fin and lying dorsal to the muscle unit controlling the fin. There are two such organs, one on each side of the body, each tapering more or less at the cephalad and caudad ends, thus giving the organs the form of much-elongated spindles. In cross-section these electric areas appear triangular in shape and are separated by the median septum.

The electric spindles are divided into five longitudinal tiers by horizontal sheets of connective tissue running the entire length of the organ. In these tiers the electroplaxes are arranged perpendicular to the septa in compartments bounded by the electrolemma and embedded in the "electric jelly." These compartments, with the electroplaxes lying in about the middle, are relatively large, with the result that the electroplaxes are rather widely separated. Since the strength of the electric current produced is proportional to the number of electroplaxes, it is safe to assume that the electric current produced by *G. carapus* must be extremely weak, if it is at all perceptible.

The electroplaxes are plainly seen in any section taken through the electric organ. They are more or less square or oblong in shape, with irregular projections (papillæ) on the cephalad and caudad sides. These papillæ are usually longer on the caudad sides. Numerous oval nuclei are arranged peripherally and no cell walls are present. The core of the electroplax is homogeneous in appearance. The nerves and blood-vessels always approach the caudad side of the plates, a condition which is similar to that found in the electric eel and other Gymnotids.

It is thus evident that the tissue which Miss Lowrey has described as degenerated muscle units is really an electric organ. Her mention of "strands of cartilage" being intermingled with the degenerated muscle leads me to believe that she has seen the electroplaxes and interpreted them as being cartilage. They are usually of a homogeneous, hyaline appearance and with their numerous nuclei might present a cartilaginous appearance. Yet their form is that so characteristic of electric plates that one can not overlook them.

Another of the Gymnotids which Miss Lowrey has examined and reported to possess no electric organs is *Eigenmannia virescens*. In the posthumous work of Sachs (1881) on *Gymnotus electricus*, some of his field notes are published which describe and figure por-

tions of the body which he considered to be the electric organs of *Eigenmannia* (*Sternopygus*). It is interesting to note that his description of the macroscopic appearance of the electric organs exactly fits that of *Gymnotus carapus* presented here.

From an evolutionary standpoint, the weak or pseudo-electric fishes form a subject of interesting speculation. The Gymnotids (except *Electrophorus electricus*, the electric eel) and certain of the Raiidæ possess these weak electric organs. Darwin, in his "Origin of Species"[2] has admitted that the electric organs of fishes present difficulties to his theory of natural selection. Are the weak electric organs rudimentary, or are they new organs in the process of progressive development? If they are rudimentary why have they been discarded; if they are new organs just beginning to appear, of what selection value can they be if they produce no perceptible electric current? Only a study of the development of these organs can throw light on these questions. In certain of the Raiidæ which have been investigated it seems quite evident that the electric organs have been recently acquired and are not, therefore, the rudiments of previously existing well-developed ones.

ELMER L. SHAFFER
PRINCETON UNIVERSITY,
December 14, 1916

[2] P. 167, sixth edition.

THE AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

THE eighth annual session of the Pharmacological Society took place on December 28, 29 and 30, 1916, at Cornell Medical School, New York City. The other members of the Federation of American Societies for Experimental Biology met at the same time and place.

The sessions were opened and concluded by a joint meeting of all four societies. The papers read at these meetings will be found in the report of the General Secretary of the Federation. In addition to these joint meetings, the Pharmacological and Physiological Societies held a joint session devoted entirely to demonstrations on Friday afternoon, December 29.

Officers for 1917.—The following officers were elected for the present year:

President: Reid Hunt.

Secretary: L. G. Rowntree.

Treasurer: Wm. deB. MacNider.

Additional Members of the Council: John Auer, Carl Voegtlin.

Membership Committee: Torald Sollmann (term expires 1919).

New Members: The following candidates were elected to membership upon recommendation by the membership committee and the council: Franklin C. McLean, Union Medical College, Peking, China; Harold B. Meyers, University of Oregon; Maurice I. Smith, University of Michigan; Julius M. Rogoff, Western Reserve University; James A. Waddell, University of Virginia.

Membership in the A. A. A. S.—The attention of new members is called to the following resolution of the council of the American Association for the Advancement of Science:

> *Resolved,* that the entrance fee to this association shall be remitted for members of regularly affiliated societies who are elected to the A. A. A. S. within one year of their election to membership in the affiliated society.

The extension of this privilege (it was formerly limited to the year 1916 only) to all new members of affiliated societies *for the year in which they join the affiliated society,* is greatly to be welcomed, and all new members of the Pharmacological Society should avail themselves of this opportunity.

Amendment of the Constitution.—The mandatory provision of Article V., Section 1, that the annual meeting of the society be held between December 25 and January 1 at a place determined by the council was altered to read: "The annual meeting of the society shall be held at a time and place determined by the council in consultation with the executive committee of the Federation of American Societies for Experimental Biology." The federal executive committee, it may be added, is formed by the presidents and secretaries of the constituent societies of the federation.

The object of this amendment was to permit a tentative change of the meeting time, if a majority of the federated societies should deem this advisable. There are a number of reasons why the scientific sessions should be held at some other time of the year than Christmas week: the season is usually inclement and imposes hardships and dangers on all members, especially the elderly, who are compelled to travel considerable distances in order to attend; the time available for the preparation of papers from the beginning of the

school year to December 1 when the title usually must be in the hands of the secretaries, is too short; in addition the December meetings interfere with, and for many practically abolish, the Christmas holidays as a family festival.

Privileges of Discussion.—As a number of inquiries were received during the last two years concerning the privilege of discussing papers before the Pharmacological Society by members of the Federation who do not belong to the Pharmacological Society, it was moved, seconded and unanimously carried that this privilege be accorded to all members of the Federation. At the same time, the executive committee-members of the society were instructed to propose before the executive committee of the Federation that all the constituent societies grant the same privilege, so that any member of one society is entitled to join the discussion of any paper delivered before any other society.

It should be noted that this motion refers only to the privilege of the floor; it obviously does not confer the right to read a paper before a society of which the author is not a member. Such a transfer can only be made after the consent of the secretary of that society has been obtained before which the paper is to be read.

Meeting Place in 1917.—The next meeting of the Pharmacological Society, together with the other members of the Federation, will be held at the University of Minnesota in Minneapolis.

Dinners and Smokers.—Two informal dinners and smokers were given, the first at the Hotel McAlpin on December 28, and the second at the Chemists Club on December 29. At the first dinner, with Dr. Simon Flexner as toastmaster, speeches were delivered by Drs. Mendel, Pearce, Carlson, Cannon and Jones.

Scientific Program.—Before giving a list of the papers read and discussed, it may be mentioned with satisfaction that all papers announced by their authors for delivery were read with but one exception, and in this instance the title was changed.

DECEMBER 28, 2.00–4.30 P.M.

"Pharmacological Studies with Cocain and Novocain," by G. B. Roth.

"The Fate of Iodin, Iodids and Iodates in the Body," by T. Sollmann.

"The Fate of Strychnin in the Animal Body," by R. A. Hatcher and Cary Eggleston.

"The Reduction of Toxicity of Strychnin by the Simultaneous Administration of Large Quantities of Fluid," by I. S. Kleiner and S. J. Meltzer.

"The Action of Strychnin in Cardiac Arythmias," by M. I. Smith (by invitation).

"Bio-Assay and Variability of Veratrum Preparations," by J. D. Pilcher.

"The Pharmacological Activity of Digitalis Grown in America," by J. H. Pratt and H. Morrison (by invitation).

"Digitalis in Cardiac Irritability," by C. C. Guthrie.

"The Toxicity of Digitalis for Normal and Vagotomized Cats," by D. I. Macht and H. Colson (by invitation).

"Responses of Fish Melanophores to Sympathetic and Para-Sympathetic Stimulants and Depressants," by H. G. Barbour and R. A. Spaeth (by invitation).

"The Action of Fluorescin and its Derivatives on the Circulation," by W. Salant and R. Bengis (by invitation).

"The Action of Succinate and its Derivatives on the Isolated Frog Heart," by W. Salant and A. E. Livingston (by invitation).

DECEMBER 29, 9.00–12.30 P.M.

"The Effect of Unilateral Excision of the Adrenal, Section of the Splanchnic Nerve and Section of the Renal Nerves on the Secretion of the Kidney," by E. K. Marshall, Jr., and A. C. Kolls (by invitation).

"The Effect of Nicotin on the Two Kidneys after Unilateral Section of the Splanchnic Nerves," by A. C. Kolls (by invitation) and D. K. Marshall, Jr.

"The Protective Action of Diet against Renal Irritants," by W. Salant and R. Bengis (by invitation).

"A Consideration of the Relative Toxicity of Uranium Nitrate for Animals of Different Ages," by W. deB. MacNider.

"A Study of the Conditions affecting the Rate of Excretion of Phenosulphonephtalein," by R. R. Snowden (by invitation), Clyde Brooks and T. S. Arbuthnot (by invitation).

"The Action of Distilled Water on the Isolated Uterus," by C. Voegtlin and G. C. Lake (by invitation).

"A Study of Ethylhydrocuprein (Optochin) in Lobar Pneumonia," by H. F. Moore (by invitation) and A. M. Chesney (by invitation).

"Further Observations on Albuminuria and Changes in Renal Function following Full Therapeutic Doses of Salicylate," by R. W. Scott (by invitation), T. W. Thoburn (by invitation), and P. J. Hanzlik.

"The Excretion of Salicylate in Various Clinical Conditions," by R. W. Scott (by invitation), T. W. Thoburn (by invitation) and P. J. Hanzlik.

"Salicylate Oedema," by R. W. Scott (by invitation), J. L. Reycraft (by invitation) and P. J. Hanzlik.

"The Favorable, Antagonistic Effect of Magnesium Sulphate against Poisonous Doses of Sodium Oxalate," by F. L. Gates and S. J. Meltzer.

"Further Observations on the Pathological Changes in the Tissues of the Rabbit, as a result of Reduced Oxidation," by G. H. Martin (by invitation), C. H. Bunting (by invitation) and A. S. Loevenhart.

DECEMBER 29, 2.00–5.00 P.M.

Joint Demonstrations by the Pharmacological and Physiological Societies

"A Signal Magnet which writes either upwards or downwards," by W. Hale.

"Some New Apparatus," by D. E. Jackson.

"An Improved Lever for Frog's Heart and Muscle Strips," by A. H. Ryan.

"The Inhibitory Effect of Stimulation of the Central End of the Vagus Nerve upon the Contractions of an Active Expiratory Muscle in the Chicken," by A. L. Meyer (by invitation).

"Demonstration of a Gas-Analysis Apparatus," by Yandell Henderson.

"The Motion Picture as an Aid in Teaching Physiology," by J. A. E. Eyster and W. J. Meek.

"Pathescope Films used to illustrate Physiological Demonstrations to Students," by Alexander Forbes.

"Motor Phenomena of the Stomach and Cap as observed Roentgenographically," by Gregory Cole (by invitation).

"Photographs representing the Growth of Chickens Fed with Definite Mixtures of Foodstuffs under Laboratory Conditions which have heretofore not led to Success," by Thomas B. Osborne and Lafayette B. Mendel.

"Microscopic Demonstration of Absence of Chromatolytic Change in the Central Nervous System of the Woodchuck (*Marmota Monax*)," by A. T. Rasmussen (by invitation) and J. A. Myers (by invitation).

"Glycogen in the Blood Vessels of the Liver," by G. Carl Huber and J. J. R. Macleod.

"A Method of Recording Fundamental Heart Sounds Directly from the Heart," by Carl J. Wiggers and A. Dean, Jr. (by invitation).

"Exhibit of Photographically Recording Apparatus for studying the Dynamics of the Circulation," by Carl J. Wiggers.

DECEMBER 30, 9.30–12.00 M.

"Studies on Tolerance and Cumulation: Experiments with Tartrates, Citrates and Oxalates," by W. Salant and A. M. Swanson (by invitation).

"The Effect of Morphin and Opium on Psychological Reaction Time," by D. I. Macht and S. Isaacs (by invitation).

"On the Drug-fastness of Spirochætæ against Certain Arsenical, Mercurial and Iodid Compounds in Vitro," by H. Noguchi and S. Akatsu (by invitation).

"On the Relative Toxicity of Salvarsan and Neosalvarsan," by L. Pearce and W. H. Brown.

"The Action of Ethylenediamin," by H. G. Barbour and A. M. Hjort (by invitation). (Read by title.)

"The Influence of Eserin upon the Partially Excised Sphincter Pupillæ," by D. R. Joseph.

"The Mutually Antagonistic Actions of Adrenin and Eserin upon the Sphincter Pupillæ," by D. R. Joseph.

"The Effects of Pituitrin and of Adrenin of the Pupil of Gangliectomized Rabbits," by T. S. Githens and S. J. Meltzer.

"The Prolonged Reaction of the Blood Vessels of the Rabbit's Ear to the Local Injection of Adrenin," by J. Auer and S. J. Meltzer.

"The Effect of Ergotoxin on the Temperature of Rabbits," by T. S. Githens.

"A Respiratory Factor in the Production of Adrenin Pulmonary Œdema in Rabbits," by F. L. Gates and J. Auer.

At the second executive session of the society on Friday noon, December 29, a vote of thanks was unanimously tendered the authorities of Cornell Medical School for their hospitality and efficient arrangements and to the local committee for its efforts in behalf of the visiting members and guests.

JOHN AUER,
Secretary

ROCKEFELLER INSTITUTE

SOCIETIES AND ACADEMIES

THE TENNESSEE ACADEMY OF SCIENCE

THE seventh meeting (fifth annual meeting) of the Tennessee Academy of Science was held on December 1, 1916, at George Peabody College for Teachers, Nashville, Tenn. President Samuel M. Bain presided. The following papers were read and discussed:

"The Development of Transportation on the Great Lakes," by Professor A. E. Parkins, Peabody College, Nashville.

"An Apparatus for Moisture Determination,"

by Professor A. S. Eastman, University of the South, Sewanee.

"Chemists' Present Opportunities and Duties," by Dr. J. I. D. Hinds, Castle Heights School, Lebanon.

"Some Practical Applications of Bacteriological Research," by Dr. Herman Spitz, Nashville.

"The Raison d'être of the Tennessee Academy of Science," by Dr. Samuel M. Barton, University of the South, Sewanee.

"The Origin of Reelfoot Lake," by Dr. A. H. Purdue, State Geological Survey, Nashville.

"Following the Compass across Sahara," by Dr. D. W. Berky, University of the South, Sewanee.

"James M. Safford," by Dr. J. T. McGill, Vanderbilt University, Nashville.

"West Indian Hurricanes: Their Origin, Movement and Extent," by Roscoe Nunn, U. S. Weather Bureau, Nashville. (Discussed by R. S. Maddox, State Forester, Nashville.)

Annual address of the president: "The Interrelation of Plant and Animal Pathology," by Professor Samuel M. Bain, University of Tennessee, Knoxville.

The election of officers for the ensuing year resulted as follows:

President, Samuel M. Barton, University of the South, Sewanee, Tenn.

Vice-president, Archibald Belcher, Middle Tennessee State Normal School, Murfreesboro, Tenn.

Editor, A. H. Purdue, State Geologist, Nashville, Tenn.

Secretary-Treasurer, Roscoe Nunn, U. S. Weather Bureau, Nashville, Tenn.

The president appointed as members of the executive committee, Dr. Brown Ayres, University of Tennessee, Knoxville, Tenn., and Dr. John T. McGill, Vanderbilt University, Nashville, Tenn.

ROSCOE NUNN,
Secretary

NASHVILLE, TENN.

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 560th meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, November 18, 1916, called to order by President Hay at 8 P.M. with 86 persons in attendance.

On recommendation of the council, Irwin Hoffmann was elected to active membership.

Under the heading, brief notes, exhibition of specimens, Dr. O. P. Hay exhibited one of the cervical vertebræ of a deer from a deposit in Florida. He called attention to the fact that the remains of Florida deer have usually been referred to the existing species, *Odocoileus osceola.* A comparison of this vertebra with the corresponding one from recent deer, other than the Florida deer, showed that possibly the extinct Florida deer was a different species from the existing deer. Dr. Hay said that there were no examples of cervical vertebræ of Florida deer for making comparisons, and until such examples were seen the identification of the extinct deer must remain doubtful.

Under the same heading Dr. Paul Bartsch called attention to a hybrid duck which he had lately seen exposed for sale in the markets. It was a cross between the black mallard and the domestic duck.

The regular program consisted of two papers:

H. Pittier: "Forests of Panama," illustrated by lantern slides.

Professor Pittier gave first a condensed review of the results to the present date of the botanical part of the biological survey of Panama, undertaken under the auspices of the Smithsonian Institution. Then he showed how the distribution of the main ecological types of vegetation is dependent upon the régime of the winds and of the rainfall. Mixed dicotylous forests cover at least six tenths of the area of the Isthmus, the rest being occupied by savannas and park-like formations. Rain-forests with evergreen foliage extend over the entire northern watershed and part of Darien on the south side. Other forests of the southern slope belong to the type called monsoon-forest and are characterized by the presence of many species with deciduous foliage. The xerophytic character of the vegetation is more marked in the broken forests of the savanna-belt, without, however, assuming an extreme degree. The change in the composition of the vegetation with the increase in altitude has been dwelt upon by several travelers and botanical explorers of the Isthmus; it is very gradual but nevertheless very radical. Several genera of trees observed at high altitudes are gregarious; there are, for instance, oak-forests, subtropical or even temperate in their general appearance. Lantern slides illustrating types of forest, or of individual trees and flowers, were shown at the conclusion of the lecture.

J. H. Paine: "Scientific Photography in the Study of Insects," illustrated by lantern slides.

During the last half of the meeting Dr. H. H. T. Jackson was acting secretary.

M. W. LYON, JR.,
Recording Secretary

SCIENCE

FRIDAY, JANUARY 26, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-On-Hudson, N. Y.

BIOLOGY AND WAR[1]

1. BIOLOGY is not the science which can throw any light on the origin of war, since wars are caused by economic, political and social conditions. Although these conditions are in the last analysis based upon human instincts it does not seem profitable for the present to trace the connection.

It is also outside the speaker's problem to discuss the effects of war. Compared with the misery and anguish, the general loss of life and of liberty, and the economic waste caused by war, the possible hereditary effects on the population, if there are any, are too trivial to be mentioned.

As far as your speaker has been able to see, biology can at present offer a contribution to the problem of war in one direction only, namely to test some of the claims of war enthusiasts who insist that from a biological viewpoint wars are justifiable or even desirable.

2. These war enthusiasts maintain that unless a nation engages occasionally in war it will lose all those virile virtues, especially courage, which are necessary for its survival. We do not need to argue whether the acts committed in a state of homicidal emotion are the real or only manifestations of courage; we may also overlook the manifestations of virility left behind by invading or retreating armies. The assumption that virility or courage (whatever may be meant by these terms) will disappear if not practised in the form of war implies an unproven and apparently false biological assumption, namely, that functions not practised or organs not used will disappear

[1] Read at the meeting of Naturalists, December 29, 1916.

in the offspring. Such arguments were very common in biology before the experimental method was recognized as necessary to test the validity of our assumptions. Since experimental tests were made we have learned that eyes do not degenerate when animals are kept in the dark. Thus Payne raised sixty-nine successive generations of *Drosophila* in the dark without noticing any trace of degeneracy in the eye or its function. Uhlenhuth found that eyes when transplanted into the back of salamanders will (after a transitory degeneration) regenerate completely, and remain normal no matter whether the animals are kept in the dark or in the light. Hereditary blindness (*e. g.*, hereditary glaucoma in man) is apparently due to a mutation (probably a chemical change in one chromosome) which originates, as far as our present facts show, independently of use or disuse of the eye. We know through Morgan's observations that insects with mutilated or rudimentary wings may arise suddenly as mutations from parents which used their wings. Lack of the practise of flying does according to our present knowledge no more lead to the hereditary disappearance of wings than darkness leads to hereditary degeneration of the eyes. The statement, that a nation by not going to war will lose any of its inherited "virile virtues" is not supported by our present biological knowledge.

3. The biology of which the war enthusiasts make use is essentially antiquated, and so we need not be surprised to find that they consider war to be based on what they call the "biological law of nature," the "struggle for existence," or the "survival of the fittest." Such ideas are expressed by war enthusiasts in America as well as in Europe and we may be permitted to make the following quotation without giving the name of its author.

> The struggle for existence is in the life of nature the basis of all healthy development. All existing things show themselves to be the result of contesting forces. So in the life of man the struggle is not merely the destructive but the life-giving principle. . . . The law of the stronger holds good everywhere. Those forms survive which are able to procure for themselves the most favorable conditions of life and to assert themselves in the universal economy of nature. The weaker succumb. This struggle is regulated and restrained by the unconscious sway of biological laws and by the interplay of opposite forces. In the plant world and the animal world this process is worked out in unconscious tragedy. In the human race it is consciously carried out, and regulated by social ordinances. The man of strong will and strong intellect tries by every means to assert himself, . . . and in this effort the individual is far from being guided merely by the consciousness of right. . . . The nation is made up of individuals. . . . The motive which influences each member is prominent in the whole body. It is a persistent struggle for possessions . . . and right is respected so far only as it is compatible with advantage.

The "struggle for existence" and the "survival of the fittest" are no "laws of nature" in the sense in which the term law is used in the exact sciences. We speak of a law of nature when we are able to express a phenomenon as a mathematical function of its variables. We thus speak of a law of gravitation, of Ohm's law, or in biology of Mendel's law of segregation. As long as biologists did not realize that their statements needed not only a qualitative experimental test but also a quantitative verification they talked in a loose way, and this did not change until the methods of physics and physical chemistry began to invade biological research. The progress made by Mendel lay in this, that he introduced the quantitative method of the physicist into the investigations of hybridization and he was ignored because the zoologists and botanists of his time did not grasp the fact that the progress of science depends upon the invention or application of such methods.

The terms "survival of the fittest" or "struggle for existence" were never more than poor metaphors to express the fact that the chemical compounds required for the growth of organisms are restricted in quantity and that as a consequence unlimited reproduction of organisms is impossible. Aside from the limitation of food, the physical conditions (*e. g.*, too low or too high a temperature) existing on the different parts of the globe, act as a restricting influence. The methods by which the stronger "conquer" weaker nations have nothing in common with the fact that salt water fish die when put into fresh water or that microorganisms can not multiply unless they have their proper culture medium. The majority of organisms, *e. g.*, plants, bacteria of the soil, and many others, can in no way be called predatory organisms. Of course, there are animals which are as brutal and predatory as the war enthusiasts think human beings should be—but this is a different thing from calling this brutality a universal law of living nature. Fortunately the normal human being does not belong to this brutal type.

There is a wide quantitative difference in the development of instincts and of the power of inhibition in different human individuals, and these differences may be hereditary. Individuals with a strong homicidal mania, who just manage to suppress their paranoic tendencies, will welcome war since it removes for them the burden of constant inhibition, and unfortunately such poorly balanced individuals have rather too frequently been the leaders of governments. No human society can be expected to exist unless the necessity of suppressing or curbing the harmful and pathological instincts of individuals is recognized, and a nation is liable to pay a high price for the privilege of having a semipathological individual at the head of its government.

4. The war enthusiasts also derive from what they are pleased to call the "law of nature" the statement that "superior races" have the right of impressing their civilization upon "inferior races." The information concerning the relative value of races is furnished by a group of writers who call themselves "racial biologists." This "racial biology" is based on quotations from the erudite statements of theologians, philologists, historians, politicians, anthropologists, and also occasionally of biologists, especially of the nonexperimenting type. The method of standardizing the different races is consequently neither quantitative nor experimental, for, as the best known "race biologist," Houston Chamberlain, says, "there is something in the world besides compass and yard measure. Where the learned fails with his artificial construction, one single unbiased glance can illuminate the truth like a sunbeam." A few quotations from Chamberlain will show how this method of "sunbeams" is applied in special cases. Thus Chamberlain tries to prove that the Celtic Bretons in France are really Germanic.

> These Celtic minds of former centuries, teeming with strength, are not merely free and not merely pious any more than the Breton seamen of to-day, but they are both free and pious and it is this very combination that expresses what is specifically Germanic, as we observe it from Charlemagne to Queen Louise.

And as a sop to biology, Chamberlain states:

> Let us therefore not be in too great a hurry to assert that Germanicism does not lie in blood; it does lie in it; not in the sense that this blood guarantees Germanic sentiment and capacity but that it makes these possible. This limitation is therefore a very clear one: as a rule that man is Germanic who is descended from Germanic ancestors.

It will not be necessary at a meeting of biologists to state that Mendelian characters are generally inherited singly and in-

dependently, and that we know nothing about the inheritance of piety and freedom, either separately or in Germanic linkage. The writer wishes also to apologize for being compelled to point out that it is not good biology to maintain that the oblique eyes of the Chinese or Japanese are an indication of an oblique character, or that in a hybrid the "bad" qualities of the parents are dominant over the "good" ones.

5. While the statements of the war enthusiasts will not be taken seriously by those familiar with the methods and results of experimental biology, the sad fact remains that this pseudobiology has had at least a share in the production of the tragedy which is being enacted in Europe. For wars are impossible unless the masses are aroused to a state of emotionalism and fanaticism, and the pseudobiology of literateurs and politicians may serve this purpose in the future as it has in the past. The government has at last begun to realize that it is its duty to protect the masses from the medical quack. Your speaker is of the opinion that the masses need equal protection from the irresponsible literateur or politician who makes it his business to spread the seed of fanaticism and emotionalism by a claim of knowledge of biology which he does not possess. The cure for this form of pernicious mischief is the spread of knowledge of the exact sciences which will put an end to the business of the pseudoscientist.

Since at present the making of war is left in the hands of the statesmen, it may be well to mention at least that the exact sciences have paved the way for the replacement of the present type of statesmanship by a new one; according to which statesmanship consists in the application of the results of the exact sciences to the improvement of the lot of humanity. This includes not only the technical but also the theoretical results of science, since these theoretical results will free the minds from all those forms of ignorance, superstition and fanaticism which are the culture medium of mob emotionalism. If we succeed in substituting for the present a new type of statesmen, who are familiar with and follow the development of the *exact*—*i. e.*, the experimental and quantitative—sciences, and who are willing and capable of applying the results of exact science to the intellectual, moral, physical and economical uplift of the masses, we shall at least diminish the danger of war.

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ASYMMETRIC SYNTHESES AND THEIR BEARING ON THE DOCTRINE OF VITALISM. II

The fact that an asymmetric compound prepared in the laboratory is always obtained in the inactive form is in itself of no great significance. As has been already stated, the result is just what one would expect. It assumes its significance, however, when taken in conjunction with the fact that an asymmetric compound occurring in nature, with very rare exceptions, exists in the active form. In other words, it is the difference between the results of the laboratory synthesis and those of nature that impart to this general subject its remarkable interest.

The view that the production of the active forms of asymmetric compounds is characteristic of living organisms was advanced first by Pasteur. The following quotations are taken from his lecture delivered before the Chemical Society of Paris in 1860.

All artificial bodies and all minerals have superposable images. Opposed to these are many organic substances (I might say nearly all, if I were

to specify only those which play an important rôle in plant and animal life) all of which are important substances to life, are asymmetric, and indeed have the kind of asymmetry in which the image is not superposable with the object. . . . When I assert that no artificial substances with molecular asymmetry are known, I speak of artificial substances in the proper sense of the word, which are formed in all their parts from the elements, or are produced from bodies which are not asymmetric. . . . In this way the idea of the influence of the molecular asymmetry of natural organic products is introduced into physiological studies; this important characteristic is perhaps the only distinct line of demarkation which we can draw to-day between dead and living nature.

This view originally advanced by Pasteur is now so firmly established that no chemist would hesitate to take it into consideration in determining the origin of naturally occurring products. For example, it is a well-known fact that certain mineral oils found in nature are optically active and Walden, Engler and other investigators have contended that because of this property, these oils must be regarded as of organic rather than mineral origin.

The question that concerns us, however, is whether this inability to reproduce in the laboratory the results which are obtained in the living organism is due to a complete difference between the methods of the laboratory and those of nature, or whether it is due simply to lack of knowledge as to the conditions necessary for effecting the synthesis. It is evident that Pasteur inclined to the latter belief. In one of his lectures, after emphasizing that only the dextro or levo forms are produced in nature, he adds:

But why right and left molecules, why not only symmetrical molecules like those of the inorganic substances? There are certainly causes for this remarkable behavior of the molecular forces, even though it is difficult for us to get a clear conception of them. I believe that I am not deceived when I assert that we now know one of its most important characteristics. Is it not necessary and also sufficient to assume that the instant the plant organism arises an asymmetric force is active? For we have seen above that the dextro-molecule deviates from its levo-antipode only in those cases in which it is subjected to some kind of an asymmetric action. Do such asymmetric agencies arise from the cosmic influences, light, electricity, magnetism, heat? Do they perhaps stand in close relation with the earth movements, with the electric current by means of which physicists explain the earth's magnetic pole.

Pasteur put his beliefs to the test by attempting to bring about asymmetric syntheses through the agency of the magnetic field as well as of polarized light.

It is evident that nature may act in one of two ways in building up active forms. In the first place asymmetric forces may be present of which we have no knowledge, through whose influence a single active form may be built up; or both of the active forms may result just as in our laboratory synthesis but, through some agency unknown to us, one of these forms may be used up by the organism or destroyed as fast as formed. The latter view is the one most generally accepted. Attention was called to the plausibility of this view by Fischer in a lecture delivered before the German Chemical Society in 1890. In this lecture after calling attention to the fact that only the active sugars of the dextromannite series are found in plants, Fischer adds:

Are these the only products of assimilation? Is the preparation of optically active substances a prerogative of the living organism? Is there brought into action here a special cause, a kind of life force? I think not, and incline much more to the view that only the incompleteness of our knowledge imparts to such processes the appearance of the miraculous.

No known facts are opposed to the view that the plant, just as in chemical synthesis, produces at first both forms, that it then separates the two and that it uses the members of the *d*-mannite series for the formation of starch, cellulose, inulin, etc., while the optical isomers serve for some other yet unknown purpose.

While Fischer's explanation may appear plausible, nevertheless the fact that no

complete asymmetric synthesis has as yet ever been accomplished, notwithstanding the repeated efforts of many of our most skilful workers, has led some scientists to the belief that the problem does not admit of solution; that there exists in the organism some vital force or agency which directs the manner of combination of the atoms in the molecule and that this force is not reproducible in the laboratory. Such scientists, therefore, find in the facts of asymmetric syntheses an argument in support of the doctrine of vitalism—that doctrine which postulates that life is not the result of physical and chemical forces merely, but that these forces are guided through the directing agency of some vital force that comes into action with the life of the organism.

The advocates of the doctrine of vitalism criticize the assumption of Fischer cited above, on the ground that the destruction of one of the forms of an asymmetric compound partakes just as much of the miraculous as does the production of one of the forms alone; for with one possible exception the methods for accomplishing the separation require the use of already existing optically active substances. The exception referred to is the mechanical method, which is applicable, however, only when the two forms are solid compounds and separate from their solutions in crystals that are related to each other as object to image—a property which is possessed by the salts of the racemic tartaric acid. In all such cases it is readily possible to separate the two forms from each other mechanically, as Pasteur did in his original discovery. The opponents of the doctrine of vitalism hold that this constitutes a complete asymmetric synthesis; that starting with inactive substances, optically active forms have been obtained separate from each other without the use of previously existing optically active compounds, and without in any way employing the agency of life. To the vitalist, however, the action of the investigator in separating the two forms of crystals from each other is exactly similar to the action of an enzyme which destroys the one form and leaves the other in a pure state. This view is expressed by Professor Japp as follows:

> It requires the living operator, whose intellect embraces the conception of opposite forms of asymmetry, to separate them (*i. e.*, the two forms of crystals). Such a process can not, by any stretch of language, be termed "mechanical." Conscious selection here produces the same result as the unconscious selection exercised by the microorganism, the enzyme, or the previously existing asymmetric compound. . . . Only the living organism with its asymmetric tissues, or the asymmetric products of the living organism, or the living intelligence with its conception of asymmetry, can produce this result. Only asymmetry can beget asymmetry.

I can give no better summation of the views of the opposite schools of thought in regard to the bearing of the subject of asymmetric syntheses upon the doctrine of vitalism than to sum up briefly the main arguments advanced by Professor Japp in an address delivered before the British Association in 1898, as well as the arguments advanced by those who criticized the address. This latter number includes such eminent scientific men as Pearson, Spencer, Frankland, Armstrong, Fitzgerald, Errara, Kipping and Pope.

Japp bases his arguments largely upon the fact that all attempts to effect asymmetric syntheses without the intervention of life either directly or indirectly, have been futile. Neither does he think our failure to do so is due to "a temporary disability which the progress of science may remove." He calls attention to the fact that all the methods that have been used for separating a racemic form into its active constituents employed living agencies either directly or

indirectly. He likewise emphasizes the fact that all attempts to utilize the magnetic field and polarized light have met with failure and concludes that even if an asymmetric force were to be discovered it could not lead to the production of a single form of an asymmetric compound.

> No fortuitous concourse of atoms, even with all eternity for them to clash and combine in, could compass this feat of the formation of the first optically active organic compound. . . . But the chance synthesis of the simplest optically active compound from inorganic materials is absolutely inconceivable. So also is the separation of two crystallized enantiomorphs under purely symmetric conditions. . . . I see no escape from the conclusion that, at the moment when life first arose, a directive force came into play—a force of precisely the same character as that which enables the intelligent operator, by the exercise of his Will, to select one crystallized enantiomorph and reject its asymmetric opposite.

Pearson dissents strongly from Japp's view that "the chance synthesis of the simplest optically active compound from inorganic materials is absolutely inconceivable." Japp had likened the result of the process whereby the dextro and levo forms of an asymmetric compound are produced from inorganic or symmetrical materials, to the tossing of a coin. If the coin is a perfectly balanced one the chances are equal as to whether it falls heads or tails; so in the synthesis of an asymmetric compound the chances are equal for the production of the two possible forms. Pearson argues, however, that if one will toss a coin (say) twenty times that while the results in general will be ten heads and ten tails, nevertheless there will be a variation from this mean; and that if the act of tossing were to be continued an infinite number of times one might come to an instance of twenty heads or twenty tails. So in the synthesis of the dextro and levo forms of an asymmetric compound, any action which gives rise to them, carried on through the ages, must produce the two forms in unequal amounts and the form in excess would then act as "breeders" in building up other asymmetric forms.

Fitzgerald argues that life probably originated from a few centers and possibly a single center. In the former case the chances are that either the dextro or the levo form predominated, so that asymmetry might have resulted, while in the latter case asymmetry must have resulted.

Herbert Spencer in criticizing the attitude of Japp states that he does so not "for the purpose of showing the adequacy of the physico-chemical interpretation of life, but for the purpose of showing the inadequacy of Professor Japp's argument against it." Spencer insists that, even granting that the dextro and levo forms of protein were formed originally in equal numbers these would not remain mixed together, but that their separation would follow in accordance with a universal law to the effect that unlike units, when acted upon by the same forces, are affected differently and that ultimately this difference will result in the segregation of the like units; in other words, the dextro and levo forms would in the course of time separate into the two groups of like molecules.

Others criticize Japp's statement to the effect that the right- and left-handed crystals can not be separated except through the agency of life. They think it quite possible for such a separation to have been brought about by ordinary natural agencies.

Thus Bartrum holds that it is entirely conceivable that the two forms of crystals on separation might be unevenly grouped, and that conditions might change so that partial solution would take place in which the one set of crystals might be more favorably situated than the other, and that the resulting solution would then be optically active.

Errara thinks that the facts can be explained upon the assumption that the two forms generated somewhere in space, were separated by being whirled around through space, and that one of these forms reached the earth. From this all other asymmetric compounds might have originated.

Kipping and Pope give the results of experiments which prove that a single set of crystals deposited from a solution of a racemic compound is not always composed of equal amounts of the two forms, in which case not only the crystals, but the mother liquor as well, are optically active. Conditions here which give rise to the optically active substances are such as might exist in a purely inorganic world.

Professor Japp in his arguments in favor of vitalism was at a disadvantage in that his position upon the question compelled him to assume the attitude of one who denies the possibility of future advancement. He not only had to contend that none of the methods proposed would lead to an asymmetric synthesis, but that no methods ever would be discovered that would lead to such a synthesis. This latter position is a rather hazardous one to assume in these days of scientific advancement, in which the impossibilities of the one decade become the realities of the next. Aside from this attitude, the vulnerable point in Japp's position is the statement "that the chance synthesis of the simplest optically active compound from inorganic materials is absolutely inconceivable." It was against this view that most of the criticism was launched. In the subsequent discussion Japp admitted, indirectly at least, that this statement was perhaps too strong, for he adds that "all my critics seem to be moving in that unreal world where a font of type if jumbled together sufficiently often ends by setting up the text of Hamlet"—to which Frankland replies that if the font of type were jumbled an infinite number of times, the text of Hamlet *must* result.

Stewart has also called attention to another possible explanation for the generation of optically active forms in nature. Cotton (1896) proved that the two forms of copper ammonium tartrate absorb dextro-circularly polarized light unequally—a difference which would tend to favor the generation of the one form over the other in the presence of such light. Byk (1904) has shown that light is circularly polarized by reflection from water of the sea. Stewart finds in the combined observations of Cotton and Byk a satisfactory explanation for the presence in nature of optically active forms.

It is evident from the mere fact that Professor Japp's contention aroused such a series of discussions, and that these discussions apparently only served to strengthen the attitude of each of the participants in his original belief, that the facts of asymmetric syntheses can not be regarded as giving evidence at all conclusive in favor of the doctrine of vitalism. On the other hand, it must be admitted that the opponents of the doctrine have advanced no conclusive arguments in opposition to it. For while it is possible to imagine conditions under which asymmetric groups might have arisen in a purely inorganic world, nevertheless, such an argument may have little weight. To carry conviction the conditions for producing such groups must not only be possible; they must also lie within the bounds of probability. Whether or not the conditions assumed by Japp's critics to account for the production of the first asymmetric groups from inorganic materials, are probable conditions, is a question upon which there would undoubtedly be a difference of opinion. I am sure, however, that all of us would agree that some

of the assumptions made are not very plausible.

At first thought, one might conclude that, with the problem of asymmetric syntheses as with the problem of life itself, the main difficulty is to account for the initial step. Given the unit living cell, all others might have developed from this; likewise given the unit asymmetric group, this might serve as the "seed" from which all the countless forms that exist in nature may have sprung. Granting, however, that the formation of the original asymmetric group or groups is satisfactorily explained, another perplexing question at once presents itself. For with perhaps a single exception, in all the partial asymmetric syntheses effected in the laboratory, both forms have been produced. In other words, the best we can do is to synthesize the one form in excess of the other and as a rule this excess is only slight. On the other hand, out of all the infinite variety of optically active compounds found in nature, only in very rare instances are both forms found. Ordinary lactic acid, produced by the fermentation of lactose, contains both forms, although in slightly unequal amounts: *dl*-limonene (dipentene) occurs in certain turpentine oils, while levo-asparagine is found in some plants along with small amounts of the dextro compound. In the laboratory, therefore, the production of both forms is the almost invariable rule; in nature it is the marked exception. To explain this difference upon the assumption that the methods of nature like those of the laboratory lead to the synthesis of both forms, one of which is destroyed as fast as generated, is, in the light of our present knowledge, quite as unsatisfactory as is the assumption that one form only is produced.

The assumption that there exists in the living organism a vital or guiding force which directs the changes that take place within the organism has never been a popular one among chemists. It is fortunate that this is so, for to accept such a belief would be to destroy the spirit of investigation, so far as it applies to a study of many of the problems connected with the living organism. However, the chemist, familiar with the wonderful results that may be accomplished through the action of chemical forces and recognizing that as yet we have but little insight into the nature of these forces, is apt to ascribe to them powers that can not be justified in the light of the knowledge at hand.

The discovery of Wöhler that urea can be synthesized in the laboratory was of the greatest importance; but neither the synthesis of urea nor the synthesis of any other of the almost countless number of compounds effected in the laboratory actually disproves the existence of a vital force in the living organism. Likewise it is certain, to my mind at least, that while the facts of asymmetric synthesis, so far as we can discern at the present time, do not prove the existence of such a force in the living organism, neither do they present any valid argument against the belief in its existence. So far as they have a bearing upon the question, life remains as it always has been—the great mystery.

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SCIENTIFIC EVENTS

MINUTE ON THE LIFE AND SERVICES OF HUGO MÜNSTERBERG

THE following minute on the life and services of Professor Hugo Münsterberg was placed upon the records of the faculty of arts and sciences of Harvard University at the meeting of January 16, 1917:

Hugo Münsterberg, professor of psychology, died in Cambridge on the sixteenth of December, 1916. He was born in Danzig, West Prussia, June 1, 1863. After leaving the gymnasium in his native

city, he studied philosophy in Leipzig, under Wundt among others, taking the degree of Doctor of Philosophy in 1885, and went on with physiological studies in Heidelberg (M.D., in 1887).

In 1887 he habilitated at Freiburg, in Baden, and in 1891 was made professor extraordinary there. An acquaintance with William James, whom he met at a psychological congress in Paris in 1889, led to a call to a professorship of experimental psychology in this university, and he began teaching here in the fall of 1892. The academic years 1895–96 and 1896–97 were spent in Freiburg again, on leave of absence, and on his return to Cambridge in 1897 he was appointed professor of psychology. Professor Münsterberg received the honorary degree of A.M. from Harvard in 1901, LL.D., from Washington University, St. Louis, in 1904, and Litt.D., from Lafayette College in 1907. He was president of the American Psychological Association in 1898 and of the American Philosophical Association in 1908, and was a Fellow of the American Academy of Arts and Sciences and a member of the Washington Academy of Sciences. He had a leading part in forming and carrying out the plans for the International Congress of Arts and Sciences at the St. Louis Exposition in 1904 and in the subsequent publication of its proceedings. In 1901–11 he was the Harvard exchange professor at the University of Berlin.

Münsterberg's fertility and enormous industry were conspicuous from the beginning. While still at Freiburg he published four parts of a theoretical and experimental work entitled "Beiträge zur experimentellen Psychologie," and four volumes on psychological subjects.

His first years in Cambridge were mainly spent, beside the daily tasks of instruction, in developing the psychological laboratory and fostering research. To the students who resorted to him for training in the new methods of experimental psychology he gave freely of time and interest, and his fertile invention supplied many and varied problems for investigation. The production of the laboratory steadily increased in volume and significance, and in 1903 a medium of publication was established under Münsterberg's direction in the "Harvard Psychological Studies." The well planned and equipped laboratory in Emerson Hall, opened in 1905, was chiefly due to his efforts.

His first American book appeared in 1899, a collection of essays entitled "Psychology and Life." It was followed by more than twenty volumes, besides a prodigious number of articles in periodicals. Of his more strictly scientific writings during this period the most important are "Grundzüge der Psychologie" (1900)—the first volume of a largely planned work which was never completed—"Science and Idealism" (1906), "The Eternal Values" (1909), "Grundzüge der Psychotechnik" (1914). In the latter years of his life his interest turned more and more to the applications of psychology, the practical bearings of the science on education, law, medicine and industry. To this series belong, "Psychotherapy" (1909), "Psychology and the Teacher" (1910), "Psychology and Industrial Efficiency" (1913), with many occasional publications. Münsterberg had a deep interest also in educational, social and political problems, and wrote much upon them, from "American Traits" (1901) and "Die Amerikaner" (1904), translated (1905) "The Americans," to his recent books on "The War and America," "The Peace and America" and "To-morrow" (1916).

With this great productivity, he was a notable teacher not only of advanced students in the seminary or laboratory but of large classes of undergraduates whom from year to year he introduced to the elements of psychology.

A man of strong and self-confident opinions and positive expression, he was of a kindly spirit, hospitable, generous, appreciative of others. His mental energy seemed limitless, his industry tireless, his optimism unquenchable. He exemplified his own ideal of productive scholarship, and carried to the grave with him plans for more books than most of us would think of achieving in a lifetime.

MEMORIAL TO SUSANNA PHELPS GAGE

PROFESSOR SIMON HENRY GAGE and his son Henry Phelps Gage, Ph.D. Cornell 1909, have given to Cornell University ten thousand dollars as a memorial to Susanna Phelps Gage, Ph.B. 1880, who was the first woman to take laboratory work in physics in that institution and who in her subsequent career as a neurologist showed the highest appreciation of the need for research in our country.

The fund thus established is to be known as the *Susanna Phelps Gage Fund for Research in Physics in Cornell University.*

It is the wish of the donors that the income be administered by the professors of physics with the cooperation of the president of the university; and that it be used in any way which at the time gives promise of advancing knowledge in physics. The

income could therefore be properly applied to a graduate fellowship or scholarship, the purchase of apparatus, of books and periodicals or for any other purpose which at the time and occasion give promise of advancing knowledge.[1]

The first installment of income becomes available at the beginning of the second half century of the university (1918–19).

On Wednesday evening. January 10, 1917, the members of the physics seminary and a few friends dined together at the University Club in Ithaca, on which occasion the establishment of the new research fund was celebrated. In expressing to the donors the appreciation of the department of physics Professor Nichols said:

The value of a gift like this, the income of which from year to year is placed freely at the disposal of those who are responsible for the promotion within the university of one of the fundamental sciences, to be expended in whatever manner from time to time may be most advantageous to the furtherance of research, is inestimable. It comes, moreover, at a time peculiarly opportune; when public opinion is aroused to some realization of the importance of research to human welfare. The history of science and industry teaches clearly that applied science upon which the material welfare of the race so greatly depends, advances only with the growth of pure science and that the university affords the most favorable, indeed, almost the exclusive, atmosphere in which research flourishes. Hence the demand, now beginning to be heard, not so much from within academic circles as from outside, that the universities of this country make the advancement of learning their prime function. Every such gift as this furthers that great end.

Modest though it be, in comparison with what men of great wealth may do for science without the least personal denial, this fund is especially welcome in that it comes from men of science and is given in a spirit of devotion to science and of real self sacrifice.

It is a notable and gratifying evidence of the unity of the scientific spirit that this fund for the promotion of physics is established in memory of one whose life was given to biology and who attained eminence by her contributions to that sister science; and that one of the donors who is with us to-night, and whom we delight to honor, is himself a biologist of renown.

[1] Quotation from the deed of gift.

On behalf of my present colleagues of the department of physics I accept this gift. We shall endeavor to expend the income from it in the spirit in which it is given and in loving recognition of the generosity and devotion of the donors. In generations to come, we may rest assured, the noble intent of the donors will ever influence those intrusted with its administration and that thus it will ever be used for the true advancement of science.

THE AMERICAN INSTITUTE OF MINING ENGINEERS

THE program of the one hundred and fourteenth meeting of the American Institute of Mining Engineers, which convenes in New York City on February 19, has been issued. Sessions will include the annual business meeting and presentation of papers on subjects of scientific interest in the mining field. In addition, a number of special social features are being planned, including an all-day excursion by special train to West Point, where the engineers will view a number of exhibitions and inspect the grounds of the Military Academy. According to registrations received, this year's prosperity of the mining camps in the middle and far west will be reflected in the attendance at the February meeting. Individuals connected with practically all of these will take some part in the technical sessions.

The meeting will extend over four days, and will open on February 19, with sessions on geology, metallography, petroleum and gas, and milling and smelting. On the following day, sessions will be held on iron blast furnace practise on flotation. The principal sessions of the third day will be held on the manufacture of iron and steel.

Among the papers which will be presented are:

"Recent Geologic Developments on the Mesabi Iron Range, Minn.," by J. F. Wolff.

"Grain Growth Phenomena in Metals," by Henry M. Howe and Ray Jeffries.

"Evidence of the Oklahoma Oil Fields on the Anticlinal Theory," by Dorsey Hager.

"Magnetic Concentration of Low-Grade Magnetic Iron Ore," by S. Norton.

"The Conservation of Phosphate Rock in the United States," by W. C. Phalen.

"Potash as a By-product from the Blast Furnace," by R. J. Wysor.

"Significance of Manganese in American Steel Metallurgy," by F. H. Willcox.

The committee on arrangements for the convention includes: David H. Browne, chairman; Lawrence Addicks, P. E. Barbour, George D. Barron, Karl Eilers, Louis D. Huntoon, H. A. Megraw, Thomas T. Read, Burr A. Robinson, F. T. Rubidge, E. Maltby Shipp, Bradley Stoughton, Edward B. Sturgis and Arthur L. Walker.

APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE

The House Bill making appropriations to the U. S. Department of Agriculture for the fiscal year ending June 30, 1918, is now under discussion. The main bill carries a total appropriation for routine and ordinary work of $24,221,081. To this great amount are added other sums bringing the total amount carried in the bill to $25,694,085. The amounts appropriated to the scientific bureaus are as follows:

Weather Bureau	$1,778,320
Bureau of Animal Industry	3,528,286
Bureau of Plant Industry	2,769,630
Forest Service	5,711,195
Bureau of Chemistry	1,212,311
Bureau of Soils	363,855
Bureau of Entomology	911,980
Bureau of Biological Survey	589,510
Office of Public Roads and Rural Engineering	702,100

SCIENTIFIC NOTES AND NEWS

Sir William Crookes, the distinguished English chemist; Dr. C. A. Angot, director of the French Bureau of Meteorology, and Professor August Gärtner, professor of hygiene, University of Jena, have been elected foreign members of the Academy of Sciences of Sweden.

The Elisha Kent Kane medal of the Geographical Society of Philadelphia was, on January 19, conferred on Dr. William Curtis Farabee. Dr. Farabee gave before the society an illustrated lecture on "Exploration in the Amazon Valley and in the Unknown Guinea, 1913 to 1916." Dr. Farabee has also had conferred upon him the gold medal of the Explorers' Club of New York.

Professor E. F. Northrup, research physicist of Princeton University, has been awarded the Elliott Cresson medal by the Franklin Institute "in recognition of his electrical inventions and high temperature investigations."

Professor Wilbur M. Wilson, of the department of civil engineering at the University of Illinois, was honored by the Western Society of Engineers at its annual meeting on January 10, by having conferred upon him the Octave Chanute medal, in recognition of the fact that a paper presented by him in 1915 was judged to be the best in the field of civil engineering presented before the society during that year. The medal was established in memory of Dr. Octave Chanute, whose studies in the field of aerodynamics were notable.

Brigadier General Joseph E. Kuhn has been appointed president of the War College.

E. D. Ball, formerly director of the Utah Station, has been made state entomologist of Wisconsin, vice J. G. Saunders resigned to succeed H. A. Surface as economic zoologist of Pennsylvania.

Professor Werner has been appointed director of the Heidelberg Institute for the Investigation of Cancer established by the late Professor Czerny.

After twenty years' service in the New York Department of Health, Dr. John S. Billings, now deputy commissioner of health and director of the bureau of preventable diseases, has offered his resignation, to take effect on May 1.

Earl B. Smith, formerly with the U. S. Office of Public Roads and Rural Engineering has been transferred to the U. S. Bureau of Soils as mechanical engineer. His work will be on engineering lines in the design and construction of the new government potash plant at Summerland, California, where he, with Dr. Turrentine, of the Department of Agriculture, will investigate the commercial possibilities of extracting potash, iodine, tar

products, acetone, etc., from the kelps of the Pacific coast.

DR. L. H. BAILEY, Mrs. Bailey and Miss Bailey are preparing to leave Ithaca at the end of this month for a tour of the Far East to last the greater part of a year.

ROALD AMUNDSEN has definitely postponed the execution of his plans for an expedition to the north pole until after the war. His ship was almost equipped for the trip, which was to have lasted three or four years, and the crew had been hired; but the money difficulties proved insuperable. The necessary expenses of the expedition in consequence of war prices have mounted from $135,000 to double that figure.

THE annual meeting of the Brooklyn Entomological Society was held on January 13 and the following officers were elected for 1917: President, W. T. Bather; Vice-president, W. T. Davis; Treasurer, C. E. Olsen; Recording Secretary, J. R. de la Torre Bueno; Corresponding Secretary, R. P. Dow; Librarian, A. C. Weeks; Publication Committee, J. R. de la Torre Bueno, C. Schaeffer and R. P. Dow.

DR. JAMES R. ANGELL, of the University of Chicago, is giving a course of lectures on "The Makers of Modern Psychology" on the Spencer Foundation at Union College.

A COURSE of twenty-four lectures on ore deposits is being delivered before the department of geology of Columbia University by Professor John D. Irving, professor of economic geology, Sheffield Scientific School, Yale University.

PROFESSOR F. J. METZGER, of the department of chemical engineering, Columbia University, has resigned his position to accept the position of manager of chemical development, with the Air Reduction Company, New York.

UNIVERSITY AND EDUCATIONAL NEWS

THE late Dr. John A. McCorkle had set aside in trust bonds of the market value of $50,000 which became payable to the Long Island College Hospital upon his death. A committee of prominent citizens, headed by the Honorable Edgar M. Cullen, is endeavoring to raise an equal amount as a memorial fund to Dr. McCorkle.

A GIFT of $50,000 to the principal of the alumni fund, subject to an annuity, from a graduate of the class of 1867, Yale College, was announced at the last meeting of the corporation. This is the second gift of like amount and under similar conditions that has been made to the credit of the class of 1867 in the alumni fund. There has also been received, from Robert W. Kelley, '74, class agent and a director of the fund, $125,000 (subject to an annuity as to four fifths of the amount), the whole to be added to the Yale Alumni Fund as an addition to the permanent memorial fund of 1874.

DR. WILLIAM WISTAR COMFORT, professor of the Romance languages and literatures and head of the department at Cornell University, has been elected president of Haverford College. He will succeed Dr. Isaac Sharpless, who will retire after completing a service of thirty years in the Haverford presidency.

J. O. RANKIN has resigned as agricultural editor at the Missouri Station to become associate professor of agricultural economics at the Iowa College, and is succeeded by M. N. Beeler, agricultural editor at the University of Florida.

DR. RAOUL BLANCHARD, professor of geography and director of the Institute of Geography at the University of Grenoble, has been appointed exchange professor at Harvard for 1916–17. His term of service will fall in the second half year.

DR. V. A. COULTER, Ph.D., has been appointed assistant professor of chemistry in the University of North Carolina.

DISCUSSION AND CORRESPONDENCE

NEGATIVE SURFACE TENSION

IN a recent number of SCIENCE (November 24, 1916) Professor W. A. Patrick in a note on "Ostwald's Handbook of Colloidal Chemistry," expresses doubt as to the existence of negative surface tension, and suggests that it

can scarcely be conceived without assuming a force of repulsion instead of attraction between molecules of the liquid.

But he surely can not mean to question the existence of negative surface tension at a surface *between a liquid and solid,* for how otherwise are we to explain the most familiar facts in capillarity. Is it not negative surface tension which causes the water to rise in a capillary tube, or against a glass wall, and causes a drop of oil to expand indefinitely over a glass plate? Is it not the greater negative surface tension in the oil-glass surface which causes the film to expand against the contractile force, or positive surface tension of the oil-air surface?

Nor does it appear to be necessary to suppose a repulsive force between molecules of the liquid in order to account for the existence of such a negative tension, for if the resultant force of attraction on a particle of liquid near the surface, due to all particles on both sides of the surface lying within the range of sensible molecular attraction, is directed away from the surface and towards the interior of the liquid, the particle will tend toward the interior and we shall have positive surface tension but if the resultant attraction is toward the surface there will be negative surface tension.

In case of an air-liquid surface the attraction of neighboring liquid particles upon a particle in the surface is so much greater than any opposing outward attraction by adjoining air molecules that the first condition holds and the surface tension is positive. While at a glass-oil surface a particle of liquid near the surface may be supposed to be more strongly attracted by the neighboring glass molecules than by the oil molecules in its vicinity, in which case the resultant attraction is toward the glass, the potential energy of a liquid particle is less at the surface than in the interior of the liquid, and the surface tension is negative.

When liquid comes against liquid the case is complicated by the mobility of particles on both sides of the boundary. It seems probable, however, taking an oil-water surface as an example, that if the resultant attraction on an oil molecule at the surface is directed across the boundary from the oil side toward the water, that a water molecule at the surface being in the same situation with respect to the surrounding molecules will be urged in the same direction. In other words, we can hardly imagine a particle of one sort in the surface as being drawn in one direction by the attraction of all the surrounding particles on both sides of the surface, while a similarly situated particle of the other sort would be drawn in the opposite direction.

We may assume then that at a surface between two liquids, particles on one side are urged away from the surface, while those on the other side are urged toward it. That is, there are two influences, one tending to contract the surface and the other to expand it. If the first is predominant there is positive surface tension, this is the ordinary case where diffusion does not take place, as with water-oil or water-mercury.

If the second is predominant the surface tends to expand indefinitely, and the limit would seem to be reached only when one liquid is uniformly diffused throughout the other. In this case diffusion is to be expected also from the consideration that if particles in the one liquid are drawn so powerfully towards the other as to force the expansion of the second liquid in opposition to its contractile tendency, it seems probable that they will be drawn actually *into* the second liquid and thus the integrity of the surface be destroyed. We conclude, therefore, that *a positive surface tension is to be expected between all liquids that do not interdiffuse.*

If the particles in a colloid solution are to be regarded as solid, we may expect to find cases where the surface tension is positive and other cases where it is negative. Where it is positive there will be a tendency to flocculate, for as two colloid particles come together liquid particles move out from between them into the interior of the liquid, and the capillary region surrounding the particles is thus decreased in volume, and the potential energy of the system is diminished. When, on the other

hand, the surface tension is negative at the surface of a colloid particle, there will be no flocculation, and the particles will not approach each other near enough to crowd the liquid out of the region of surface energy around either particle. This, of course, does not imply that there is any tendency in the latter case for the colloid particles to remain in equilibrium equally diffused throughout the liquid.

ARTHUR L. KIMBALL
AMHERST COLLEGE

THE WHITE PINE BLISTER RUST; DOES THE FUNGUS WINTER ON THE CURRANT?

IN the work carried out in the Province of Ontario during the last two years on this disease, strong suspicions have been aroused that the fungus may in some cases pass the winter on the currants themselves. Several lines of evidence support these suspicions.

1. The commencement of the currant stage each spring here and there over large areas, without any apparent relation to the pines therein.

2. The similar yearly recurrence of the currant rust in one particular district ten miles by four miles in extent. In this area (*a*) the rust outbreaks do not bear any apparent relation to the pines; (*b*) the pines are very few in number; (*c*) many lots of these pines are small and their freedom from disease has been established; (*d*) the evidence from five lots of these young pines growing close to infected currants indicates that the rust was not introduced into this area until 1914, and that therefore the prevalent currant stage of 1915 and 1916 could not be due to pine blisters, which have not yet had time to mature.

3. The finding of six cases of the currant stage early in the year from one to two miles distant from any possible source of pine infection.

4. The occurrence of currant rust in 1916 on two adjacent plants in a large plantation. Early in the year these two only were rusted. The only four plants which were badly diseased here in 1915 included these two.

5. The occurrence of a rust outbreak on a plot of one hundred black currant plants which were badly rusted in 1914, and which had been set out in a disease-free neighborhood in the spring of 1915 to test hibernation.

A hypothesis is advanced which gives a reasonable explanation of the suspected hibernation. The rust often causes early defoliation of the currant plants, and this defoliation is followed by a secondary production of foliage, due to the development of winter buds. The general occurrence of the rust on these secondary leaves suggests that, allowing for the two weeks' incubation period, the infection must take place very early in their growth, and the question naturally follows: can such started buds be infected at such an early stage in their development that if winter conditions set in soon after, the buds are still capable of surviving?

W. A. MCCUBBIN
DIVISION OF BOTANY,
EXPERIMENTAL FARM SYSTEM,
DOMINION OF CANADA,
November, 1916

PAMPHLET COLLECTIONS

TO THE EDITOR OF SCIENCE: I note in SCIENCE for November 24, an article by Tracy I. Storer from the University of California on "The Care of Pamphlet Collections" in which a type of cardboard case open at the back only and "not larger than $12 \times 8 \times 2\frac{1}{2}$ inches" is recommended for this purpose. Permit me to state that such cases differing only in size—mine are $11 \times 7 \times 3$ inches—have been in use in my department since 1904. Several other departments in the university had such cases made after my design and they have been in rather general use here since. I do not remember whether the idea is original with me or not. These cases are arranged alphabetically by authors and the card index is by subject with the catch word first on the card.

CHAS. B. MORREY
DEPARTMENT OF BACTERIOLOGY,
OHIO STATE UNIVERSITY

INDUSTRIAL LABORATORIES AND SCIENTIFIC INFORMATION

TO THE EDITOR OF SCIENCE: The undersigned committee on engineering of the General Committee on Research, of the American Associa-

tion for the Advancement of Science, feel that it is timely to issue the following appeal to the industrial research laboratories of the country.

In the course of work done in the numerous industrial laboratories of America, many physical and commercial constants and data of great scientific interest and value are doubtless arrived at, which may, for a certain period of time, constitute an asset of considerable commercial value to the particular corporations in question. During this period, every one recognizes the proprietary right of the industrial laboratories to the retention of this information.

A time frequently arrives, however, when such scientific information loses its commercial value (often by being duplicated in other laboratories), and just at this point we wish to impress upon the industries their obligation to enrich scientific literature with such facts and data, which might otherwise be lost or forgotten.

Some of our industries have been reproached with the suspicion of acting as sponges, in that they absorb an immense amount of useful information from scientific literature without giving any return in kind. This suspicion would be entirely removed if, from time to time, scientific information which has ceased to be of commercial value were contributed by them to its appropriate channel and thus became available to all scientific workers throughout the world.

If any doubt exists as to the appropriate channel for the publication of such scientific data and communications, the general secretary of the American Association for the Advancement of Science, Dr. J. McKeen Cattell, Garrison-on-Hudson, New York, will be glad to act as intermediary and to forward such communications to the proper scientific body.

A. E. KENNELLY,
J. W. RICHARDS,
A. SAUVEUR,
A. N. TALBOT,
C. C. THOMAS

CAMBRIDGE, MASS.,
January 18, 1917

SCIENTIFIC BOOKS

Lectures on Ten British Mathematicians of the Nineteenth Century. By ALEXANDER MACFARLANE. No. 17 of the Mathematical Monographs, edited by Mansfield Merriman and Robert S. Woodward. John Wiley and Sons, New York, 1916.

This posthumous publication contains most interesting biographies of ten of the leading mathematicians of the nineteenth century in Great Britain, namely, of George Peacock, Augustus De Morgan, Sir William Rowan Hamilton, George Boole, Arthur Cayley, William Kingdon Clifford, Henry John Stephen Smith, James Joseph Sylvester, Thomas Penyngton Kirkman, Isaac Todhunter.

These sketches are a part of the lectures given by Dr. Macfarlane at Lehigh University during the years 1901–04. "In a future volume it is hoped to issue lectures on ten mathematicians whose main work was in physics and astronomy." The author's personal acquaintance with some of these men, and with intimate friends of them, enabled him to add personal touches which will be relished by the reader. Particularly gratifying are the details about Boole and Kirkman, concerning whom little had previously appeared in print. The future historian of mathematics during the nineteenth century will find the booklet full of interesting material. The lecturer's aim was evidently to set forth the personalities whose scientific achievements were already known to the listener. Hence the scientific researches of these men are not described, but merely mentioned.

Illuminating information is given in several of the biographies relating to Great Britain as "an examination-ridden country," and relating to the effects of the theological tests formerly demanded of candidates for degrees and competitors for certain prizes. The opinions on the teaching of mathematics held by some of the English mathematicians are valuable at the present time when in the United States the mind-training-value of mathematical study is called into question.

The booklet is manufactured in attractive

form. Carelessness in the proof-reading is noticeable. Frequently letters are dropped out of words, their unceremonious departure being accentuated by the blank spaces left behind. The description of Newton's fluxional notation on page 9 is rendered unintelligible to one not already familiar with it by the omission in several instances of the necessary dots. The spelling on page 35 of Clairaut as "Clairault" is unusual, to say the least. The statement, page 120, that it was in 1872 that a deputy professor was appointed at Oxford to carry on the work relinquished by Sylvester is evidently wrong, since Sylvester was appointed to the Oxford position in 1883. It is too bad that the editors of this book allowed the repetition of the erroneous statement that the name of Sylvester's father was Abraham Joseph Sylvester. As recently stated by several writers, the name "Sylvester" did not belong to the father, but was assumed by an elder brother of the mathematician who had come to the United States, and later by the mathematician himself. The father's name was Abraham Joseph. The editors might also have corrected a mistake thus far almost universal, to the effect that Peaucellier was the first to devise an instrument for drawing a perfect straight line. It is a matter of great historical interest that a Frenchman by the name of Sarrut achieved this several years before Peaucellier, and in a manner quite different. An account of it will be found in the *Comptes Rendus,* Vol. 36, 1853, page 1036. Attention to Sarrut was called in 1905 by G. T. Bennett of Emmanuel College, Cambridge, in an article published in the *Philosophical Transactions,* 6th S., Vol. 9, page 803. Bennett gives interesting historical details, and also noteworthy developments of his own.

FLORIAN CAJORI

COLORADO COLLEGE,
COLORADO SPRINGS, COLO.

The Whalebone Whales of New England. By GLOVER M. ALLEN. Memoirs of the Boston Society of Natural History, Vol. 8, No. 2, pp. 107–322, pls. 8–15, text-figs. 1–12. September, 1916.

Dr. Glover M. Allen's "The Whalebone Whales of New England" treats of the three genera and six species of baleen whales "inhabiting the waters off the New England coast," with special reference to their habits, manner of occurrence, economic importance and technical history. Two "keys" are given for their identification, one for stranded specimens that can be approached and examined, the other for identification in life, based on their characteristic actions, the presence or absence of a fin on the back, and the size and form of the spout.

Following a few introductory pages of comment on the classification of whales in general and of the New England species in particular, the author deals at length with each of the living species, with a brief account of the single fossil species, long known from a few vertebræ and other fragmentary remains found at Gay Head, Marthas Vineyard. The North Atlantic right whale (*Eubalœna glacialis*) is of special interest historically on account of its having been the basis of the early New England whale fishery. This phase of the subject is presented in considerable detail (pp. 131–172), with many quaint extracts from early colonial records.

The species treated are: (1) North Atlantic right whale (*Eubalœna glacialis*), (2) common finback (*Balœnoptera physalus*), (3) pollack whale (*B. borealis*), (4) blue whale (*B. musculus*), (5) little piked whale (*B. acuto-rostratus*), (6) Atlantic humpback (*Megaptera nodosa*). A methodical and concise account of each is given under appropriate subheadings, beginning with "history and nomenclature," followed by descriptions of their external and osteological characters, habits and food, seasons of occurrence, pursuit and economic products, enemies and parasites. Five of the species are illustrated by full-page plates of the external form, drawn to scale from careful measurements. Outline drawings of skulls are given in another plate, several photographic views of whales in another, and vertebræ and other fossil remains from the Miocene deposits of Gay Head in another. The monograph thus forms a valuable addi-

tion to the literature of the subject, constituting, as it does, the first attempt to treat comprehensively this important part of the marine mammal fauna of New England, and is a highly satisfactory summation of present knowledge of the subject. A bibliography of six pages (about 100 titles) gives references to the technical literature cited in the text, in addition to which are numerous footnote and other references in the text to historical records relating to the distribution and occurrence of the species in New England waters, from early colonial times to the present.

J. A. ALLEN
AMERICAN MUSEUM OF NATURAL HISTORY

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE eleventh number of Volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

Path Differences within which Spectrum Interferences are Observable: Carl Barus, Department of Physics, Brown University. The method of observing interferences in the zeroth, first, second, third, and even fourth order, successively, without essential change of the parts of the apparatus is noteworthy. The present experiments furnish a striking example of the uniform breadth of the strip of spectrum carrying the fringes, quite apart from the dispersion of the spectrum.

Non-Reversed Spectra of Restricted Coincidence: Carl Barus, Department of Physics, Brown University. The method, apart from any practical outcome, is worth pursuing because of the data it will furnish of the width of the strip of spectrum carrying interference fringes under any given conditions.

The Equilibrium between Acids and Bases in Sea Water: Lawrence J. Henderson and Edwin J. Cohn, Wolcott Gibbs Memorial Laboratory, Harvard University. The ocean, which, because of the presence of free carbonic acid, was originally acid, and which has been becoming more alkaline from the accumulation of basic material, is at present in an epoch where the growing alkalinity is checked by the *buffer* action of acids of approximately the strength of boric acid. These buffers regulate the reaction of sea water in a manner similar to the way in which bicarbonates and phosphates regulate the reaction of blood.

An Apparent Correspondence between the Chemistry of Igneous Magmas and of Organic Metabolism: Henry S. Washington, Geophysical Laboratory, Carnegie Institution of Washington. The object is to call attention to what appears to be a congruous relation of two pairs of elements in the organic world; it would appear that iron and sodium are necessary for animal metabolism, while magnesium and potassium are essential to vegetable metabolism.

The Oaks of America: William Trelease, Department of Botany, University of Illinois. A summary of a manuscript now prepared for submission to the academy for publication as one of its scientific memoirs. 354 species of oaks, of which about one half are new, are recognized. The relations to fossil oaks are pointed out.

A Set of Independent Postulates for Cyclic Order: Edward V. Huntington, Department of Mathematics, Harvard University. Five postulates are given for cyclic order.

A New Method of Studying Ideational and Allied Forms of Behavior in Man and Other Animals: Robert M. Yerkes, Psychological Laboratory, Harvard University. A description of the author's method of multiple choices for the deduction of reactive tendencies and the study of their rôle in the attempted solution of certain types of problem. The method involves the presentation to the subject of a problem or series of problems whose rapid and complete solution depends upon ideational processes.

Electrical Conduction in Dilute Amalgams: Gilbert N. Lewis and Thomas B. Hine, Department of Chemistry, University of California. The resistance of amalgams of lithium, sodium and potassium is studied at constant pressure and shows extraordinary differences; the resistances at constant average atomic volume are also calculated and found to differ materially from those at constant pressure.

Ideational Behavior of Monkeys and Apes: Robert M. Yerkes, Psychological Laboratory, Harvard University. The general conclusions which may be deduced are that the ape exhibits various forms of ideational behavior, whereas the reactive tendencies of monkeys are inferior in type.

The Osmotic Pressure and Lowering of the Freezing-Point of Mixtures of Salts with one another and with Non-Electrolytes in Aqueous Solutions: William D. Harkins, R. E. Hall and W. A. Roberts, Kent Chemical Laboratory, University of Chicago. The general result obtained with mixtures already investigated is that the lowering of the freezing-point of the mixture is very nearly that which would be calculated on the basis that each salt produces a lowering of the freezing-point proportional to its own concentration and to the mol-number which it has when present alone in a solution of salt concentration.

Certain General Properties of Functions: Henry Blumberg, Department of Mathematics, University of Nebraska.

Sphenacodon Marsh, A Permocarboniferous Theromorph Reptile from New Mexico: Samuel W. Williston, Walker Museum, University of Chicago. Reconstruction of a fossil reptile found in a bone bed from which some collections were made as early as thirty-eight years ago, but which seems to have been almost forgotten until recently.

On Volume in Biology: Lawrence J. Henderson, Chemical Laboratory of Harvard College. When equilibrium has been established in a heterogeneous system (capillary and gravitational phenomena being absent) the volume of the phases is not relevant to the state of the system, but in nearly all physiological changes the regulation of volume is of great importance.

EDWIN BIDWELL WILSON

MASS. INSTITUTE OF TECHNOLOGY,
CAMBRIDGE, MASS.

NOTES ON METEOROLOGY AND CLIMATOLOGY

TWO POPULAR WEATHER BOOKS

THE scientific book on meteorology, with its numerous tables, plates and figures is too expensive and too bulky, not to mention too technical for light reading. There are three standard American meteorological treatises. Professor W. M. Davis's "Elementary Meteorology"[1] is finely written and illustrated, but on account of advances in meteorology in the past twenty years it needs to be supplemented by Professor W. I. Milham's "Meteorology"[2] or by Dr. W. L. Moore's "Descriptive Meteorology."[3] There is ample room for the small, easily read books on instruments,[4] weather processes, and forecasting. Two such books deserve particular mention: "Our Own Weather," by Edwin C. Martin,[5] and "Reading the Weather," by T. Morris Longstreth.[6] The first is a carefully written, lucid account of weather processes. After a discussion of the general character and circulation of the atmosphere, the author takes as his main theme the cyclones and anticyclones of the United States and their secondary phenomena. At the end is a chapter on weather signs and superstitions. Rarely, there are weak spots. The cause of the deflection of the wind by the rotation of the earth is not "that a body of air travelling from the equator toward the poles carries with it an eastward speed acquired at the equator and exceeding always that which it finds in the parts to which it goes" (p. 23). When any body on the earth's surface is set in motion it is deflected by the disturbance of the equilibrium between gravity and the centrifugal tendency.[7] Elsewhere (p. 33) the author says that the stop in temperature fall with increase in altitude, and the reduction in wind velocity "above the seven-

[1] Boston, 1894, 4to, 355 pp., 106 figs., 6 charts.

[2] New York, 1912, 4to, 549 pp., 157 illustrations, 50 charts.

[3] New York, 1910, 4to, 344 pp., 81 figs., 45 charts.

[4] *Cf.* "Weather and Weather Instruments." Taylor Instrument Companies, Rochester, 1908, 8vo, 175 pp.

[5] New York, 1913, 8vo, 281 pp., 8 cloud plates, 8 maps.

[6] Outing Series 43, 1915, 12mo, 8 cloud plates.

[7] See Wm. Ferrel, "A Popular Treatise on the Winds," New York, 1889, pp. 42–88; or Davis, *op. cit.*, pp. 101 et seq.

mile level are thought to be due to as sudden a change in the constitution of the air itself, to especially a large loss in nitrogen and oxygen and an accession of hydrogen." So far as is known there is no sudden change in the air composition at this or any other level.[8] On the other hand, the author is to be credited with keeping constantly before the reader such important points as that warm air does not rise of itself, but, as he states concerning thunderstorm formation (p. 242):

> It is mainly under the atmospheric movements set up by cyclones that the bodies of cold air descend and begin to root out the bodies of hot air with the abruptness that makes thunderstorms.

Also, the precipitation of atmospheric moisture by cooling due to internal expansion of rising air is well emphasized. On both these points, Mr. Longstreth gives false impressions.

"Reading the Weather," is for those who want to know simply how to forecast the weather either with or without instruments. It is a lively account of keen personal observations of weather signs, set in a brief and mainly accurate explanation of weather processes. The central theme is "sky signs for campers." These the author expounds under the heads clouds, temperatures, rain and snow, dew and frost, thunderstorm, tornado, hurricane, cloudburst and halo. For the particular benefit of the commuter, a chapter on forecasting with a barometer follows. At the end of the book is a good account of the seasons, the Weather Bureau, and weather proverbs. Finally, a summary of all the prognostics previously described adds greatly to the value of the book for reference. On account of limited scope some of the physical explanations are made too brief for accuracy. Thus the definitions of anticyclone and cyclone are hardly scientific:

> The anticyclone (cyclone) is an accumulation of air that has become colder (warmer) than the air surrounding it (pp. 20 and 44).

The author, himself, shows the limitations of these definitions when speaking of summer temperatures:

> The clear skies of the preceding anticyclone had permitted the land to warm up very fast under the midsummer sun, and the clouds of the cyclone, by cutting off the supply, had made a relative chill (p. 89).

Although the book was written largely on the northeastern United States, its value is not by any means limited to this section of the country.

Charles F. Brooks

Yale College

[8] See table and diagram pp. 46–47 in A. Wegener: "Thermodynamik der Atmosphäre," Leipzig, 1911. The results of analyses of air samples taken at 9 km. altitude, 1910 to 1912, as compared with the earth's surface, indicate a reduction of about 6 per cent. in the volume of carbon dioxide, and an increase of perhaps 50 per cent. in the lightest gases: see *Scientific American Supp.*, December 23, 1916, p. 414.

DR. JULIUS VON HANN[9]

With the passing of 1915, fifty years have elapsed during which Julius von Hann has edited the *Meteorologische Zeitschrift.* Dr. Hann edited the *Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie* with C. Jelinek from its establishment in 1866 until 1876; and, after his death, alone to the year 1885. On merging it with the German Meteorological Society's *Meteorologischen Zeitschrift* under the title of the latter, he pursued the editorship in common with Köppen from 1886 to 1891, with Hellman, 1892 to 1907 and since then with Süring.

This 50-year editorial jubilee in connection with a scientific magazine is unique. Furthermore, never has there been an editor who even made so many contributions to his scientific magazine as he. No fewer than 134 extensive articles, 1123 smaller contributions, 166 reviews and numerous unsigned articles, have come from him. In addition he has written many monographs, and he has published what are now the most exhaustive and authoritative treatises on climatology and meteorology.[10]

[9] Taken mostly from the frontispiece by Hellmann, Köppen, and Süring, *Meteorologische Zeitschrift*, January, 1916, Vol. 33.

[10] Hann's "Handbuch der Klimatologie," third ed., 1908–1911, 3 vols., 8vo, 1,533 pp., 41 figs. "Lehrbuch der Meteorologie," third ed., 1914–1915, with Dr. Süring in collaboration, 4to, 847 pp., 28 pl., 4 tables, 108 illustrations.

SPECIAL ARTICLES

THE ROOT-ROT DISEASE OF THE APPLE IN VIRGINIA

AN unusually destructive rotting of the roots of apple trees is prevalent in the chief orchard sections of Virginia. The infectiousness of this condition is shown in the death of adjoining trees in groups of considerable numbers irrespective of soil conditions or topography and the death of replants set in holes from which rotted trees were removed.

The symptoms of this disease have been known for some time, but the causative organism has not been determined.

Isolations from diseased roots by the writers from a number of orchards in the "Valley" and "Piedmont" sections of the state have yielded cultures of an imperfect fungus which appears to be the conidial stage of a species of *Xylaria*. Inoculations made from pure culture of these isolations into bark wounds of living apple roots in both damp chambers and in the field have produced typical rotting of the bark and wood, and the introduced fungus has been obtained in pure culture from the margins of these infected portions.

Recently perithecial stromata of *Xylaria polymorpha* (Pers.) Grev. have been found on roots of apple trees in various stages of typical root-rot attack and on the stumps of several deciduous trees in a small patch of woodland immediately adjoining the orchard in question. Cultures obtained from germinated ascospores of this fungus are being used for additional inoculations into apple roots.

Pending the results of these inoculations, it seems reasonably certain that a species of *Xylaria* is responsible for the root-rot disease of the apple in Virginia. It is possible that more than one species of *Xylaria* is involved, since certain constant cultural distinctions exist between some of the isolations; these, however, may be varietal rather than specific.

Apparently all varieties of the apple are susceptible and probably equally so. Observations indicate that the disease may be spread in cultivation or in the removal of borers, in contact between roots systems of diseased and healthy trees, and by surface washing of spores or other infective material.

F. D. FROMME,
H. E. THOMAS
VIRGINIA POLYTECHNIC INSTITUTE

THE AMERICAN MATHEMATICAL SOCIETY

THE twenty-third annual meeting of the American Mathematical Society, which was held at Columbia University on Wednesday and Thursday, December 27–28, 1916, was in several respects an exceptional occasion. It took place in the midst of the convocation week series of meetings of the American Association for the Advancement of Science and its long train of affiliated societies, and was immediately followed by the second annual meeting of the newly organized Mathematical Association of America, with which the society has not only a large common membership, but also a general community of interest highly beneficial to both. The annual meeting is always one of the largest of the year, being the season of the election of officers and other members of the council and the transaction of important business. This year it was especially marked by the delivery of the retiring address of President E. W. Brown, of Yale University, who chose as his subject "The relations of mathematics to the natural sciences." This was presented before a joint session of the American Mathematical Society, the Mathematical Association of America, the American Astronomical Society, and Section A of the American Association, and was followed by the retiring address of Vice-president A. O. Leuschner, of Section A, on "Derivation of orbits—theory and practise." A joint dinner of four organizations was held on Thursday evening at the Park Avenue Hotel, with an attendance of 143 members and friends. Much of the credit for the great success of the meetings is due to the joint committee on arrangements and to the program committees of the Mathematical Association.

Under all these favorable circumstances the attendance at the four sessions of the society exceeded all previous records, the number of members present being 131. President Brown occupied the chair, being relieved by Vice-presidents Hedrick and Snyder and Professor G. D. Olds. The council announced the election of the following persons to membership in the society: Professor H. H. Conwell, University of Idaho; Mr. Robert

Dysart, Boston, Mass.; Dr. Mary G. Haseman, Johns Hopkins University; Mr. J. B. Scarborough, North Carolina Agricultural and Mechanical College; Mr. J. J. Tanzola, U. S. Naval Academy. Ten applications for membership in the society were received.

In response to an invitation received from the department of mathematics of the University of Chicago, it was decided to hold the summer meeting and colloquium of the society at that university in 1919. Committees were appointed to arrange for the summer meeting of 1917 and to publish the Cambridge Colloquium Lectures, which will probably appear in the early summer.

The total membership of the society is now 732, including 75 life members; the annual published list will be issued in January. The total attendance of members at all meetings, including sectional meetings, during the past year was 490; the number of papers read was 205. The number of members attending at least one meeting during the year was 278. At the annual meeting 235 votes were cast. The treasurer's report shows a balance of $10,198.38, including the life membership fund of $6,039.87. Sales of the society's publications during the year amounted to $1,434.28. The library now contains about 5,377 volumes, excluding unbound dissertations.

At the annual election, which closed on Thursday morning, the following officers and other members of the council were chosen:

President: L. E. Dickson.

Vice-presidents: A. B. Coble, E. B. Wilson.

Secretary: F. N. Cole.

Treasurer: J. H. Tanner.

Librarian: D. E. Smith.

Committee of Publication: F. N. Cole, Virgil Snyder, J. W. Young.

Members of the Council to serve until December 1919: G. C. Evans, L. A. Howland, G. H. Ling, R. L. Moore.

The following papers were read at this meeting:

J. E. Rowe: "The relation of singularities of the rational quintic in space to loci of the rational plane quintic."

C. A. Fischer: "Linear functionals of n-spreads."

H. B. Mitchell: "Geometrical limits for the imaginary roots of a polynomial with real coefficients."

Arnold Emch: "A theorem on the curves described by a spherical pendulum."

J. K. Whittemore: "Spiral minimal surfaces."

J. R. Kline: "Concerning the complements of countable infinities of point sets of certain types."

L. L. Dines: "On projective transformations in function space."

C. C. Grove: "Foundation of the correlation coefficient."

O. E. Glenn: "Preliminary report on invariant systems belonging to domains."

Norbert Wiener: "Certain formal invariances in Boolean algebras."

L. P. Eisenhart: "Theory of transformations T of conjugate systems."

E. V. Huntington: "Complete existential theory of the postulates for serial order."

E. V. Huntington: "Complete existential theory of postulates for well-ordered sets."

Daniel Buchanan: "Orbits asymptotic to an isosceles-triangle solution of the problem of three bodies."

Daniel Buchanan: "Asymptotic satellites about the straight-line equilibrium points."

Daniel Buchanan: "Asymptotic satellites about the equilateral-triangle equilibrium points."

G. M. Green: "Isothermal nets on a curved surface."

A. L. Miller: "Systems of pencils of lines in ordinary space."

W. L. Hart: "On an infinite system of ordinary differential equations."

W. L. Hart: "Linear differential equations in infinitely many variables."

E. V. Huntington: "A set of independent postulates for cyclic order."

E. V. Huntington: "Sets of independent postulates for order on a closed line."

Frank Morley: "The cubic seven-point and the Lüroth quartic."

J. L. Coolidge: "The intersections of a straight line and hyperquadric."

A. D. Pitcher: "Biextremal connected sets."

H. H. Mitchell: "Proof that certain ideals in a cyclotomic realm are principal ideals."

H. H. Mitchell: "On the asymptotic value of sums of power residues."

Edward Kasner: "Certain systems of curves connected with the theory of heat."

Teresa Cohen: "On a concomitant curve of the planar quartic."

P. F. Smith: "A theorem for space analogous to Cesàro's theorem for plane isogonal systems."

W. E. Story: "Some variable three-term scales of relation."

E. W. Brown, Presidential address: "The relations of mathematics to the natural sciences."

A. O. Leuschner, Vice-presidential address, Section A: "Derivation of orbits—theory and practise."

G. D. Birkhoff: "A class of series allied to Fourier's series."

G. D. Birkhoff: "Note on linear difference equations."

G. A. Miller: "Groups generated by two operators of the same prime order such that the conjugates of the one under the other are commutative."

H. S. Vandiver: "On the power characters of units in a cyclotomic field."

Henry Taber: "On the structure of finite continuous groups."

The San Francisco Section of the society held its twenty-eighth regular meeting at the University of California on November 25. The Southwestern Section held its tenth regular meeting at the University of Kansas on December 2. The seventh regular meeting of the society at Chicago was held on December 22–23. The next meeting of the society will be held at Columbia University on February 24.

F. N. COLE,
Secretary

THE AMERICAN GENETIC ASSOCIATION

THE thirteenth annual meeting of the association was held at Columbia University, December 26–28, with an attendance of about 200. In the presidential address on "The Importance of Photographs in Presenting Genetic Discoveries," Dr. David Fairchild insisted that men of science should take more pains properly to record the results of their investigations by photographs; that such photographs as are commonly published are too small and also fail to make the desired impression because too little allowance is made for the reader's point of view. He showed lantern slides to illustrate his remarks.

Professor E. E. Barker, of Cornell University, presented the results of a questionnaire sent to American colleges, which showed great diversity in the amount of attention given to genetics, and the side from which it is approached.

In discussing "The Biological Significance of Death" Professor F. H. Pike, of the College of Physicians and Surgeons, Columbia University, referred to the independence of the environment which higher forms of life have attained, mainly through the property of regulation. This independence has made differentiation possible, but the individual has also become incapable of any great change. If evolution is to take place, it must then depend on the variations accompanying the production of new individuals. The immortality of the older forms would produce a congestion of the earth which would seriously interfere with the development of the newer. Death is therefore to be regarded as an adaptation, as Weismann supposed, which furthers evolution.

"The Constructive Aspect of Birth-Control" was discussed by Professor Robert J. Sprague, of Massachusetts Agricultural College. He observed that birth-control is only a part of the larger problem of population; that the poorer classes need to practise more birth-control but the more efficient classes need to practise distinctly less than they do at present, if the race is to evolve progressively. A constructive program of economic and social changes, which would help to make fecundity correlated with eugenic value, was outlined.

Professor W. S. Anderson, of the University of Kentucky, spoke on "Some Difficulties in Breeding Blooded Stock." The production of blooded horses is particularly hindered by the infertility of brood mares, which in different parts of Kentucky runs from 35 per cent. to 65 per cent. Investigation has proved that the difficulty usually is to be found in the mare, rarely in the stallion, and by hygienic measures the fertility of mares on the Patchen Wilkes stock farm has been doubled. Selection of fecund strains is believed, however, to be necessary for complete removal of the difficulty of infertility.

As chairman of the committee on research in eugenics, Dr. Frederick Adams Woods, of the Massachusetts Institute of Technology, presided at the second meeting and read a paper on "Significant Evidence for Mental Heredity." Much of the evidence commonly cited he believes to be worthless, but by measurements of differences it is possible to get acceptable proof. Studies of twins by Galton and Thorndike, and those of the royal families of Europe by the speaker himself, were cited. Princes who inherited thrones were not found to be more conspicuous mentally than their younger brothers, despite the greater chance which a monarch has for displaying any valuable traits he may possess. Moreover, eminent men are found to be as much interrelated in America as in Europe, although it is popularly supposed that superior opportunities and free competition in a newer country make family connections of less value. The fact that eminent men are found, despite this, to be much interrelated indicates that their mental differences are germinal and not solely the result of educational and social influences.

Mary L. Read, director of the School of Mothercraft, New York City, had the topic "Eugenics

and the Education of Young Women." She emphasized the necessity for sex-differentiation in education, for the teaching of mothercraft, and described her own work in this connection.

Professor Roswell Hill Johnson, of the University of Pittsburgh, discussing "The Eugenic Aspect of Sexual Immorality," pointed out that sex offenders, for a variety of reasons, have a lower birth-rate than do moral people. Further, he argued that the sexually immoral as a class are eugenically inferior to the more socially-minded part of the population. It follows that sexual immorality is a eugenic agency, tending to reduce the racial contribution of an inferior class. Campaigns for sex-hygiene, then, can not be considered directly eugenic; on the contrary, they will have some dysgenic result, which should be counteracted by appropriate eugenic measures.

Professor Robert DeC. Ward, of Harvard University, considered "The War in Relation to Eugenics—a Problem for the United States." He expects a large immigration of an undesirable class after the war, and described the need for some such law as that now pending in Congress, to shut out such arrivals as are biologically inferior.

Arthur H. Estabrook, of the Eugenics Record Office, told of "A Field Survey of Mental Defectives in Two Counties in Indiana." Only the feeble-minded, insane and epileptic were considered; in one county the proportion of defectives was found to be 19 per 1,000 population, and in the other 11.4.

As vice-chairman of the committee on research in plant-breeding, G. N. Collins, of the Bureau of Plant Industry, presided over the third meeting. Adolph E. Waller, of Ohio State University, explaining "Xenia and Other Influences Following Fertilization," showed that xenia, properly defined, was limited to the result of triple fusion in the endosperm of angiosperms. He suggested the name *ectogony* to cover the various other phenomena now wrongly included under the name of xenia—such phenomena as are represented by the common belief that the sugar content of watermelons is reduced if the flowers have been pollinated by pumpkins.

Donald F. Jones, of the Connecticut Experiment Station, reported on "The Effect of Heterozygosis upon the Time of Maturity." As one expression of hybrid vigor, he cited a cross of two varieties of tomatoes which showed a constant small difference in time of production of fruit during four years in which they were grown. Four F_1 generation crosses between these varieties grown during four different years with their parents and compared with them had approximately the same time of production as the earlier parent. The same condition was observed in a cross between an early and a late variety of sweet corn. In a large number of crosses between inbred strains of dent maize there was a tendency to hasten the average time of flowering and maturing of the crosses as compared with their parents. The conclusion was drawn that heterozygosis may not only increase size but also permit of the production of that increased size in less time, hence greatly increasing the rapidity of growth. In respect to the time to complete growth, heterozygosis does not effect a result comparable to that produced by environmental factors, since, usually, external conditions which result in an increase in growth tend to delay maturity.

C. W. Moore, of Cornell University, described some "Studies in Semi-sterility" on *Tradescantia*, Alsike Clover, Alfalfa and Shirley Poppy. Results favored Compton's hypothesis that self-sterility in plants is analogous to rust-immunity in wheat. By this view it is supposed that the pollen-tube in a cross continues to grow in order to get adequate food supply; while in self-pollination the nutritive conditions are more favorable, the pollen-tube does not have to elongate much, and it therefore does not grow enough to permit fertilization.

J. B. Norton, of the Bureau of Plant Industry, described 10 years of asparagus breeding on Cape Cod, disease resistance being the primary object. Remarkable success has been secured, by hybridization and selection, in getting disease-resistant and highly productive varieties.

Professor C. E. Myers, of Pennsylvania State College, reported on "Some Preliminary Experiments in Cabbage Breeding." All characters hitherto tested in cabbage have appeared to blend in heredity, but it is believed that this is due to the mongrel nature of the stocks. When varieties were inbred for a few generations, and then crossed, segregation was observed.

Professor H. H. Love, of Cornell University, spoke on "Some Results obtained from Certain Crosses of *Avena*." One probable case of linkage has been found.

Five papers were read by title only. The last session of the association was a joint one with the Botanical Society of America. The next meeting will be at Pittsburgh, December 28–30, in accordance with the plans of the American Association for the Advancement of Science.

Paul Popenoe,
Secretary pro tem.

SCIENCE

FRIDAY, FEBRUARY 2, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-On-Hudson, N. Y.

ANTAGONISM AND PERMEABILITY[1]

BY antagonism we mean that one toxic substance acts as an antidote to another. A solution containing salts in the proper proportions may have none of the toxic action of the individual salts. Such a mixture has been called by Loeb a physiologically balanced solution. It is found that physiological balance is of the greatest importance not only for marine organisms, but also for fresh-water and terrestrial plants and animals: these considerations have found practical application in agriculture.

In the hope of throwing light on the cause of antagonism the speaker made experiments on the penetration of salts into the cell. It was found that while NaCl alone penetrated rapidly the addition of a little $CaCl_2$ delayed penetration. It therefore seemed as though calcium antagonized sodium by preventing more or less completely its entrance into the cell. This idea had been suggested by Loeb but had not received experimental support.

These experiments (which included a number of salts) were carried out by means of the method of plasmolysis. This method did not yield quantitative data of the desired precision, but it was found possible to obtain much more accurate results by the method of electrical conductivity. By this method we measure the resistance offered by protoplasm to the passage of ions. In sodium chloride the resistance rapidly diminishes until it becomes stationary: this means that in NaCl the permeability of the protoplasm rapidly increases until death occurs,

[1] Address delivered before Section G, American Association for the Advancement of Science, at a symposium, December 27, 1916.

after which it remains fixed. In $CaCl_2$ the permeability at first decreases until a certain minimum is reached: after this it begins to increase and finally reaches a constant value (as in NaCl), which signifies death.

Further experiments showed that all substances which affect permeability may be divided into two groups, (1) those which act like NaCl; (2) those which act like $CaCl_2$. This led to the following hypothesis: Substances of the first group antagonize substances of the second group and vice versa.

Experiments were then made to test this hypothesis. It was found that substances which behave like NaCl with respect to antagonism (in experiments on growth) behave like NaCl in their effect on permeability. Substances which behave like $CaCl_2$ with respect to antagonism also behave like $CaCl_2$ in their effect on permeability. Moreover, substances like $LaCl_3$, which antagonize NaCl more powerfully than does $CaCl_2$, are found to affect permeability more powerfully than $CaCl_2$. There is therefore a striking parallel between effects on permeability and the antagonistic effects observed in experiments in which growth and length of life are employed as criteria of antagonism.

Equally remarkable is the outcome when permeability is used as the criterion of antagonism. It is found that all solutions which permit normal growth are likewise solutions which preserve normal permeability.

These experiments which were originally made on *Laminaria* were afterward extended to other algæ, to flowering plants and to animals.

Using permeability as a criterion of antagonism, the speaker has made investigations on a great variety of substances. Time is lacking to describe these, but it may be said that the outcome in every case has supported the hypothesis. This was strikingly shown in investigations on organic substances (non-electrolytes), a number of which were found to belong to the second group. It turned out that all of these substances were able to antagonize NaCl, as is required by the hypothesis.

This result greatly strengthened the speaker's confidence in the hypothesis which seems to serve a useful purpose by enabling us to predict what substances will antagonize each other.

As the result of these investigations we seem to be justified in concluding that there is a close connection between antagonism and permeability. Conclusions concerning such fundamental relations should be tested, whenever possible, by a variety of methods. This task was undertaken by Dr. Brooks, who confined himself chiefly to the following methods: (1) diffusion through living tissue, (2) exosmosis, (3) change of curvature of strips of tissue.[2]

In the first of these methods different solutions were placed on opposite sides of a piece of tissue. The diffusion of salts through the tissue was then measured.

In the second method the tissue was placed for a short time in a salt solution and the rate at which substances subsequently diffused out of the cell was measured.

In the third method strips of the peduncle of the dandelion were placed in hypertonic salt solutions and the rate of penetration of the salt into the protoplasm was calculated from the rate at which the strips recovered their normal shape after being curved by the action of the hypertonic solution (the strips remaining in the solution during recovery). This gives the same kind of information as plasmolysis but avoids the most serious errors of that method.

[2] Brooks, S. C., *Proc. Nat. Acad.*, 2: 569, 1916.

It is a very striking fact that all three of these methods agree with those already described in showing that physiologically balanced solutions preserve normal permeability, while NaCl causes a rapid increase, and $CaCl_2$ an initial decrease, followed by an increase of permeability.

This general agreement can not but increase our confidence in the conclusion that permeability and antagonism are intimately connected.

Further studies have shown that permeability serves as a delicate indicator of what we may call the vitality of the organism. By this is meant a condition of normal health and vigor and the ability to resist unfavorable influences. An organism which has normal permeability (as shown by determining its electrical conductivity) behaves normally in all respects and lives a normal length of time under laboratory conditions, while one which has abnormally high permeability behaves abnormally and does not live the normal length of time. Hence it would appear that we can treat vitality quantitatively, for if the vitality of a large number of organisms is measured in this way we obtain a variation curve: this indicates that vitality may be treated in the same manner as any other character (as, for example, length or weight).

Moreover, since increase of permeability indicates injury, we have a method of measuring injury and of distinguishing quantitatively between temporary and permanent injury. It is found that great fluctuations of permeability are possible without permanent injury. These fluctuations may control the metabolism of the cell.

These studies show that all agencies which sufficiently alter the normal permeability of the protoplasm (such as poisons, excessive light, heat, electric shock, severe plasmolysis, mechanical shock, partial drying, lack of oxygen, etc.), shorten the life of the organism. This is a very striking fact and its significance seems to be unmistakable. It indicates that permeability is a delicate and accurate indicator of vitality.

An analysis of the factors which control permeability has been attempted in subsequent studies. The changes in the resistance of tissues placed in mixtures of NaCl and $CaCl_2$ have been carefully determined. These are shown in Fig. 1. A glance at the figure suggests that there are two processes, one of which causes a rise, the other a fall of resistance. It is natural to suppose that these are chemical in nature and we may assume that they are consecutive reactions by which a substance M, which determines the resistance of the protoplasm, is formed and broken down according to the formula

$$A \rightarrow M \rightarrow B.$$

It may be assumed that M is a substance at the surface of the cell which offers resistance to the passage of ions.

It is evident that if the first reaction $A \rightarrow M$ is more rapid than the second, M will be formed more rapidly than it is decomposed and will increase in amount. Eventually, as the supply of A becomes exhausted, the formation of M will go on more and more slowly, so that it will no longer keep pace with the decomposition. The amount of M will then diminish until it finally disappears or reaches a fixed minimum (this corresponds to the death of the tissue). It is evident that if the relative velocities of the two reactions $A \rightarrow M$, and $M \rightarrow B$ be properly varied the curves of resistance will rise and fall rapidly or slowly in the manner shown in Fig. 1. It can be shown that these assumptions enable us to account for all the experimental curves.

A point of importance is that the veloci-

ties of both reactions reach a minimum in a definite mixture of NaCl + $CaCl_2$. This mixture contains the molecular proportions 95.24 NaCl + 4.76 $CaCl_2$. We can account

The extent to which these assumptions enable us to predict the behavior of the tissues in various mixtures is evident from Table I.

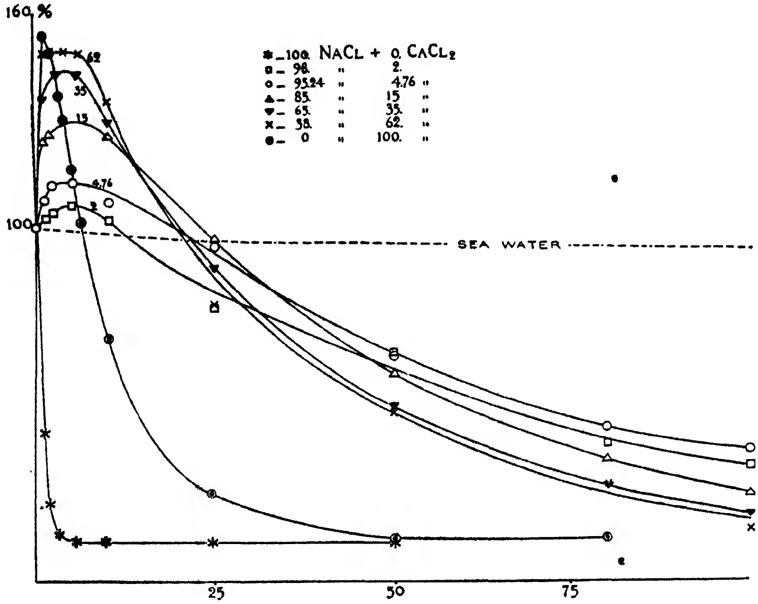

FIG. 1. Curves of electrical resistance of *Laminaria* in NaCl .52*M*, in $CaCl_2$ .278*M*, and in mixtures of these (the figures show the molecular percent. of $CaCl_2$ in the mixture).

for this if we suppose that both the reactions are inhibited by an organic salt[3] formed with a constituent X of the protoplasm according to the equation

$$2NaCl + X + CaCl_2 = Na_2XCaCl_4.$$

We may also assume that the reaction $A \rightarrow M$ is catalyzed by $CaCl_2$. This enables us to account for the fact (which is clearly evident from an inspection of the curves) that the greater the proportion of $CaCl_2$ in the mixture the higher and more rapidly the curve rises.

[3] The amount of this salt will be greatest in the mixture of 95.24 NaCl + 4.76 $CaCl_2$ if the reaction takes place in the surface and $CaCl_2$ is 10 times as concentrated in the surface as NaCl.

It is evident that the agreement between observed and calculated values is remarkably satisfactory. In regard to the theoretical procedure it should be said that in constructing equations for the curves the minimum number of constants has been employed and the attempt has been made to proceed with the fewest and the most natural assumptions. These assumptions appear to be very reasonable, for it is evident that there must be two processes in order to produce a rise and fall of resistance and that their speed must be regulated by NaCl and $CaCl_2$. It is also apparent that these salts must enter into some sort of combination with a constituent of the protoplasm and it is evident that this compound may regulate the speed of these processes.

We thus arrive at an explanation of antagonism. The theory[4] attempts to account for the following facts.

1. Why both NaCl and $CaCl_2$ are toxic.

tion of certain fundamental problems of biology.

Reference has been made to the suggestion that calcium antagonizes sodium by

TABLE I

Observed and Calculated Values of Resistance of Laminaria in Mixtures of NaCl and $CaCl_2$

Time in Hours	Per Cent. of Net Resistance in									
	98 NaCl + 2 $CaCl_2$		95.24 NaCl + 4.76 $NaCl_2$		85 NaCl + 15 $CaCl_2$		65 NaCl + 35 $CaCl_2$		38 NaCl + 62 $CaCl_2$	
	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.
1	103.1	108.7	108.2	106.8	124.5	115.6	136.1	123.8	148.1	127.2
2	103.8	105.8	112.1	111.2	126.1	124.8	141.9	136.3	149.0	141.7
3	105.8	106.7	112.1	113.8	128.5	129.8	143.2	142.2	149.0	148.0
4	106.1	106.9	113.9	115.3	130.2	132.1	143.9	144.0	149.0	149.7
5	106.1	106.6	113.1	115.8	130.2	132.7	143.9	143.6	149.0	148.8
6	104.9	106.0	113.1	115.8	130.2	132.3	143.7	141.7	149.0	146.5
10	102.1	101.8	107.9	112.5	126.5	125.1	129.5	129.8	136.1	132.6
25	76.89	84.21	95.21	93.41	96.40	93.80	87.85	87.90	78.21	86.30
50	63.90	61.70	62.50	68.20	58.11	58.83	47.81	47.80	46.34	44.46
80	38.90	43.49	42.52	47.78	33.92	35.54	26.01	25.88	27.11	23.27
100	31.80	35.09	35.83	38.33	24.01	26.58	17.33	18.90	14.42	17.03

The measurements were made at 15° C. or corrected to this figure. Each experimental figure is the average obtained from 6 series of experiments.

All the mixtures had the same conductivity as sea water.

2. Why when mixed in the proper proportions their toxicity is greatly diminished (antagonistic action).

3. Why they have opposite effects on permeability.

4. Why the decrease of permeability produced by $CaCl_2$ must be followed by an increase when the exposure is sufficiently prolonged.

5. Why all toxicity disappears in sea water. This is accounted for by supposing that in sea water A is formed as fast as it decomposes.

The theory gives a quantitative explanation of the toxicity of all the mixtures and enables us to predict the resistance (and permeability) in any mixture at any moment during exposure.

It likewise emphasizes the fact that life processes consist largely of consecutive reactions and that analysis of the dynamics of such reactions is indispensable for the solu-

preventing it from entering the cell. This explanation encounters a difficulty in the fact that even in a balanced solution the salts penetrate the cell. This difficulty disappears if we adopt the point of view which has just been presented, for it is evident that on this basis we do not regard antagonism as due to prevention of penetration. Nor is there any reason to suppose that the penetration of salts will have an unfavorable effect provided that as they penetrate into the cell the balance between them is preserved.

There is another aspect of the subject which is of considerable interest. It is usually found that when antagonistic substances are mixed in various combinations there is one proportion which is more favorable than others. If we increase the concentration of one constituent it is necessary to increase the concentrations of the others in like proportion in order to preserve the optimum condition. This law of

[4] *Cf. Proc. Am. Phil. Soc.*, 55: 533, 1916.

direct proportionality has been identified with Weber's law by Loeb, who says:

Since this law underlies many phenomena of stimulation it appears possible that changes in the concentration of antagonistic ions or salts are the means by which these stimulations may be brought about.

In view of the importance of these relations it seems desirable to ascertain what mechanism makes one proportion better than others and preserves this preeminence in spite of changes in concentration.

Precisely this kind of mechanism is involved in the theory just outlined. It is easy to see that such a mechanism must exist if the formation of Na_2XCaCl_4 takes place at a surface. In a surface substances usually exist in a different concentration from that which they have elsewhere in the solution. If NaCl and $CaCl_2$ migrate into the surface, so as to become more concentrated there than in the rest of the solution, their concentration in the surface must increase, as their concentration in the solution increases, up to the point where the surface is saturated. Beyond this point an increase in their concentration in the solution produces no effect on their concentration in the surface.

When this stage has been reached the formation of Na_2XCaCl_4, if it takes place in the surface, will not be affected by an increase in the concentration of the salts in the solution. It will, however, be affected by changes in the relative proportions of the salts. The number of molecules in a unit of surface will remain nearly constant, but if the proportion of NaCl in the solution be increased some of the $CaCl_2$ in the surface will be displaced by NaCl.

Below the saturation point the relative proportions of the salts will be of less importance than their total concentration: this is the case at low concentrations in the region of the so-called "nutritive effects."

It is evident that if we adopt this theory we can see why the most favorable proportion must remain approximately the same in spite of variations in concentration, and we thus arrive at a satisfactory explanation of Weber's law.

There are other ways in which permeability appears to be connected with stimulation. One of these has to do with anesthesia. Typical anesthetics decrease permeability. This accords with the idea that stimulation depends on the movement of ions in the tissue. Such movement would be checked by decrease of permeability.

Another has to do with mechanical stimulation. It is well known that the effects of certain kinds of stimuli can be referred directly to chemical changes which they produce in the protoplasm, but there are other kinds which appear to operate by physical means only. In the latter category are such stimuli as contact, mechanical shock and gravitation. While their action appears at first sight to be purely mechanical, they are able to produce effects so much like those of chemical stimuli that it appears probable that in every case their action must involve chemical changes.

The chief difficulty which confronts a theory of mechanical stimulation appears to be this: How can purely physical alterations in the protoplasm give rise to chemical changes? It would seem that a satisfactory solution of this problem might serve to bring all kinds of stimulation under a common point of view, by showing that a stimulus acts in every case by the production of chemical reactions.

An answer to this question is suggested by some observations on the cells of the marine alga *Griffithsia.* When one of the larger cells is placed under the microscope and touched near one end a change occurs in the chromatophores directly beneath the spot which is touched. The surfaces of the chromatophores in this region become per-

meable to the red pigment, which begins to diffuse out into the surrounding protoplasm. This change begins soon after the cell is touched. As the red pigment diffuses through the protoplasm it soon reaches neighboring chromatophores and it may be seen that their surfaces also become permeable and their pigments begin to diffuse out. In this way a wave—which may be compared to a wave of stimulation—progresses along the cell until the opposite end is reached.

The rate of propagation of this wave corresponds to that of the diffusion of the pigment. It would seem that at the point where the cell is touched, pigment, and probably other substances, are set free, diffuse out and set up secondary changes as they progress. These changes are doubtless chemical in nature.

The important question then arises: How does the contact initiate the outward diffusion of the pigment or other substances? It would seem that this may be due to a mechanical rupture of the surface layer of the chromatophores which is either not repaired at all or only very slowly. Many cases are known in which the surface layers of protoplasmic structures behave in this way. If, therefore, such structures exist within the cell, it is evident that any deformation of the protoplasm which is sufficient to rupture their surface layers will permit their contents to diffuse out into the surrounding protoplasm. A great variety of cellular structures (plastids, vacuoles, "microsomes," inclusions, etc.), possess surface layers of great delicacy and it is easy to see how some of these may be ruptured by even the slightest mechanical disturbance.

If these processes occur it is evident that purely physical alterations in the protoplasm can give rise to chemical changes. Responses to contact and mechanical stimuli may be thus explained; and since gravitational stimuli involve deformation of the protoplasm we may extend this conception to geotropism.

Further studies, which are now being made, can not be mentioned for lack of time, but it is hoped that what has been said may suffice to indicate how stimulation, vitality, injury and recovery, together with permeability and antagonism, may be brought under a common point of view and perhaps traced to similar fundamental causes.

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JOHN MUIR[1]

It is as a human being ever striving upward that I would portray John Muir.

From his early boyhood to his old age this spirit dominated him. As a child in Scotland, at every opportunity, in spite of parental prohibitions, and notwithstanding the certainty of punishment upon his return, he would steal away to the green fields and the seashore, eagerly interested in everything alive.

Illustrating this trait, I quote his boyhood impressions of the skylarks:[2]

> Oftentimes on a broad meadow near Dunbar we stood for hours enjoying their marvelous singing and soaring. From the grass where the nest was hidden the male would suddenly rise, as straight as if shot up, to a height of perhaps thirty or forty feet, and, sustaining himself with rapid wing-beats, pour down the most delicious melody, sweet and clear and strong, overflowing all bounds, then suddenly he would soar higher again and again, ever higher and higher, soaring and singing until lost to sight even in perfectly clear days, and oftentimes in cloudy weather "far in the downy cloud" . . . and still the music came pouring down to us in glorious profusion, from a height far above our vision, requiring marvelous power of

[1] Address delivered upon the occasion of the unveiling of a bronze bust by the sculptor C. S. Pietro, at the University of Wisconsin, December 6, 1916.

[2] "The Story of My Boyhood and Youth," John Muir (Houghton-Mifflin Co., 1913), pp. 46 and 47.

wing and marvelous power of voice, for that rich, delicious, soft, and yet clear music was distinctly heard long after the bird was out of sight.

At the age of eleven Muir with his father came to America to a farm beside a lake a few miles from Portage. His interest in the life of the wilderness, new to him, was thrilling. When first on Fountain Lake meadow he saw the lightning bugs, he thought to himself[3]

that the whole wonderful fairy show must be in my eyes; for only in fighting, when my eyes were struck, had I ever seen anything in the least like it. But when I asked my brother if he saw anything strange in the meadow, he said: "Yes, it's all covered with shaky fire-sparks." Then I guessed it might be something, outside of us.

Again when first he heard partridge drumming he thought,[4]

It must be made by some strange disturbance in my head or stomach, but as all seemed serene within, I asked David whether he heard anything queer. "Yes," he said, "I hear something saying boomp, boomp, boomp, and I'm wondering at it." Then I was half satisfied that the source of the mysterious sound must be in something outside of us, coming perhaps from the ground or from some ghost or bogie or woodland fairy.

Every boy who has grown up in Wisconsin and has a tinge of the love of nature will appreciate how accurately does John Muir tell of the feelings inspired in the heart of the lad, after the long cold winter, by the first migrating birds and the early spring flowers. The robin and the bluebird declare that spring is approaching, and the pasque flower shouts that spring has arrived.

Muir became intimately familiar with the southern Wisconsin flowers. He knew the gorgeous white water lily, the deliciously perfumed, delicate lady's slipper, white, pink and yellow, the scarlet painted cup, the nodding trillium and all the other beautiful early spring flowers so dear to the Wisconsin country children.

The life of the boy on the farm in pioneer days was one of hard work, and that of Muir was exceptionally hard; but he differed from the majority of his fellows in that he was not content simply to become a plowboy. Notwithstanding the prolonged physical labor, his inner spirit expressed itself, in the summer by his love of out of doors, and in the winter by study and mechanical invention.

After leaving school in Scotland at the age of eleven, Muir had little further opportunity as a boy for formal instruction. He succeeded, however, in persuading his father to get for him a higher arithmetic; and in the ends of the afternoons and in the evenings after the day's work he mastered the book; he followed this by algebra, geometry and trigonometry.

From the neighbors, and in various ways, he possessed himself of Scott's novels and the volumes of a number of the poets, including Shakespeare and Milton; and also he read the "Pilgrim's Progress," Josephus and similar works.

In the winter, immediately after prayers, he was required to go to bed; but the elder Muir, one night in repeating the order added, "If you *will* read, get up in the morning and read. You may get up in the morning as early as you like." From that time throughout the winter Muir was up at one o'clock. Although his father protested, he was held to his promise. In this manner Muir gained five hours each day, the time being used partly with his books and partly in the mechanical inventions in which he became interested—thermometers, barometers, hygrometers, pyrometers and clocks.

His more complicated clock told not only the hour of the day, but the day of the week and the month, and also had attachments which upturned his bedstead, setting him on his feet at the required hour in the morning, and other attachments to start the fire or light the lamp.

The ingenuity which young Muir displayed in mechanical construction, had he followed this talent, undoubtedly would have given him a great career as an inventor. But such a life would never have satisfied his inner impulses.

Hearing of a state fair at Madison, Muir

[3] "The Story of My Boyhood and Youth," p. 71.

[4] *Ibid.*, p. 72.

was encouraged to exhibit his various contrivances there. The extraordinary merit of his work was at once recognized, and the instruments exhibited attracted much attention. It was his visit to the fair that drew him to the university.

At Madison, Muir worked at any sort of thing, earning a few dollars. Of this he said:[5]

I was thus winning my bread while hoping that something would turn up that might enable me to make money enough to enter the state university. This was my ambition, and it never wavered, no matter what I was doing. No university, it seemed to me, could be more admirably situated, and as I sauntered about it, charmed with its fine lawns and trees and beautiful lakes, and saw the students going and coming with their books, and occasionally practising with a theodolite in measuring distances, I thought that if I could only join them it would be the greatest joy of life. I was desperately hungry and thirsty for knowledge and willing to endure anything to get it.

Of his admission to the university he says:[6]

With fear and trembling, overladen with ignorance, I called upon Professor Sterling, the dean of the faculty, who was then acting president, presented my case, and told him how far I had got on with my studies at home, and that I hadn't been to school since leaving Scotland at the age of eleven years, excepting one short term of a couple of months at a district school, because I could not be spared from the farm work. After hearing my story, the kind professor welcomed me to the glorious university—next, it seemed to me, to the Kingdom of Heaven. After a few weeks in the preparatory department I entered the freshman class.

Doing odd jobs during the term and working in the harvest fields in the summer, Muir maintained himself at the university for four years; but pursued those studies toward which he was attracted rather than a regular course. He was interested in all the sciences, and particularly in botany and geology. It was in his botanical studies about these Madison lakes that he first learned to wander. Upon leaving the university Muir says:[7]

From the top of a hill on the north side of Lake Mendota I gained a last wistful, lingering view of the beautiful university grounds and buildings where I had spent so many hungry and happy and hopeful days. There with streaming eyes I bade my blessed Alma Mater farewell. But I was only leaving one university for another, the Wisconsin University for the University of the Wilderness.

John Muir's life work was that of an explorer and a student of nature. His travels, beginning in the region of the Great Lakes shortly after leaving the university, extended throughout the world, and continued to old age. His journeys carried him to Russia, Siberia, Africa, Australia, South America, and other remote regions little visited by the ordinary traveler. But his contributions to knowledge were mainly due to his studies in California and Alaska.

It was inevitable that after reaching California Muir should be drawn by an irresistible attraction to the Sierra Nevada. His first visit filled him with burning enthusiasm; and during some ten years he studied the flora, the fauna, the glaciers, and the topography of that superb range. His study of animals and plants was not that of systematic biology—the interior structures or methods of life growth—indeed was very unlike that in the biological laboratories of the present day. His interests were rather in the habits of the plants and animals and their relations to their neighbors and to their environment. Each animal or plant as an individual was a subject of interest to John Muir. The mighty silver firs, the sugar pines, the Douglas spruces and the gigantic sequoia were ever inspiring him; and he never ceased to write of their beauty and their majesty. However, he was no less moved by the dwarf cedars, pines and oaks, which near the timber line carried on a brave struggle through the years against the terrific storms and prolonged cold of the heights.

The wonderful variety and beauty of the flowers of the Sierra also deeply stirred him. With enthusiasm he sought and admired each species, whether found for the first time or an old friend.

The animals and their habits thrilled him with delight. There have been no more ap-

[5] *Ibid.*, p. 274.

[6] *Ibid.*, pp. 275–76.

[7] "My Boyhood and Youth," pp. 286–287.

preciative nature studies ever written than that of the cheery, dauntless songster, the water-ouzel and that of the lively, demonstrative, and pugnacious Douglas squirrel. In short, his study of plants and animals was an appreciation of them as objects of nature, such as have been made by only two other Americans, John Burroughs and Henry Thoreau; and Muir worked on a far larger scale than either. He was one of the great interpreters of nature.

Muir's interpretation of plant and animal life is always humanistic without being false or sentimental, as has been too frequently true of the modern nature writers. The rigid scientific man reads his descriptions with pleasure; and, while they are clothed with human warmth, he finds them in accord with strict truth.

But John Muir's most profound emotion was aroused by magnificent scenery, and this he always saw in its relations to sky and cloud.

The Sierra Nevada he thus epitomizes:[8]

> Along the eastern margin of the Great Valley of California rises the mighty Sierra, miles in height, reposing like a smooth, cumulus cloud in the sunny sky, and so gloriously colored, and so luminous, it seemed to be not clothed with light, but wholly composed of it, like the wall of some celestial city. Along the top, and extending a good way down, you see a pale, pearl-gray belt of snow; and below it a belt of blue and dark purple, marking the extension of the forests; and along the base of the range a broad belt of rose-purple and yellow, where lie the miner's goldfields and the foothill gardens. All these colored belts, blending smoothly, make a wall of light ineffably fine, and as beautiful as a rainbow, yet firm as adamant.
>
> It seemed to me the Sierra should be called not the Nevada, or Snowy Range, but the Range of Light. And after ten years spent in the heart of it, rejoicing and wondering, bathing in its glorious floods of light, seeing the sunbursts of morning among the icy peaks, the noonday radiance on the trees and rocks and snow, the flush of the alpenglow, and a thousand dashing waterfalls with their marvelous abundance of irised spray, it still seems to me above all others the Range of Light, the most divinely beautiful of all the mountain-chains I have ever seen.

Muir's explorations of the Sierra brought to the public as never before the wonders of its river-worn ravines, its enormous glacier-cut canyons, its mighty cliffs, and its craggy peaks. From the fiery, dusty foothills to the white granite, snow-covered crests, he knew the Sierra as an intimate friend; and through his vivid writings he communicated his glow to all admirers of the sublime in nature.

After years of climbing in the Sierra, the magnificence of Alaska attracted Muir, and four times he visited that region. His explorations there represent the most important part of his geographic work; they added much to the knowledge of the Alaskan coast. A number of important inlets were mapped, the chiefest of which is Glacier Bay. In the latter was discovered the majestic glacier which bears Muir's name, a mighty stream of ice, in its broadest part twenty-five miles wide and having two hundred glacial tributaries. As compared with this, the greatest of the Alpine glaciers is a pigmy.

Muir's close observations upon the motion and work of glaciers, first the small ones of the Sierra, and later the mighty ones of Alaska, were important contributions to the knowledge of these great agents of erosion.

Muir saw that the mountains of the Sierra and Alaska, while apparently immutable and unalterable, are now being shaped by the same processes that formed them. Storms which drove the ordinary human being indoors were an ardent invitation to John Muir. Of one of the storms of the Sierra he writes:[9]

> It was easy to see that only a small part of the rain reached the ground in the form of drops. Most of it was thrashed into dusty spray, like that into which small waterfalls are divided when they dash on shelving rocks. Never have I seen water coming from the sky in denser or more passionate streams. The wind chased the spray forward in choking drifts, and compelled me again and again to seek shelter in the dell copses and back of large trees to rest and catch my breath. Wherever I went, on ridges or in hollows, enthusiastic water

[8] "The Mountains of California," John Muir (The Century Co.), pp. 4–5.

[9] "The Mountains of California," John Muir, pp. 262–63.

still flashed and gurgled about my ankles, recalling a wild winter flood in Yosemite when a hundred waterfalls came booming and chanting together and filled the grand valley with a sealike roar.

After drifting an hour or two in the lower woods, I set out for the summit of a hill 900 feet high, with a view to getting as near the heart of the storm as possible. In order to reach it I had to cross Dry Creek, a tributary of the Yuba that goes crawling along the base of the hill on the northwest. It was now a booming river as large as the Tuolumne at ordinary stages, its current brown with mining-mud, washed down from many a "claim," and mottled with sluice-boxes, fence-rails, and logs that had long lain above its reach. A slim footbridge stretched across it, now scarcely above the swollen current. Here I was glad to linger, gazing and listening, while the storm was in its richest mood—the gray rain-flood above, the brown river-flood beneath. The language of the river was scarcely less enchanting than that of the wind and rain; the sublime overboom of the main bouncing exultant current, the swash and gurgle of the eddies, the keen dash and clash of heavy waves breaking against rocks, and the smooth, downy hush of shallow currents feeling their way through the willow thickets of the margin. And amid all this varied throng of sounds I heard the smothered bumping and rumbling of boulders on the bottom as they were shoving and rolling forward against one another in a wild rush, after having lain still for probably 100 years or more.

It is at the time of storm that the large work of erosion is done. The great storm of the year may do more work than all the other storms of the year; and possibly the great storm of the century more work than all the other storms of the century.

John Muir's explorations of the Sierra and in Alaska were done alone. He had no pack train; his entire outfit he carried on his back, a sack of bread and a package of tea for food (as long as they lasted), his scientific instruments and his note book constituted his load; he had neither rod nor gun, usually no blanket, and seldom a tent except when chance threw him in with others.

This means to those who have been in the mountains and on the glaciers that Muir was wet for days and nights, that throughout many nights he was cold, that he was frequently hungry; yet to these discomforts, which would be intolerable to a less hardy man, Muir appeared oblivious.

Climbing in the mountains by one's self, as did Muir, is one of the most exacting of the physical arts. The semiprofessional climbers, who climb in order to write articles for magazines, go with not less than two professional guides, the three being roped together. Only those who have *done* climbing will appreciate how unlike are the two methods. When three are roped together, if one makes a mistake, in all probability his life is saved. When a man is climbing alone on a steep or vertical cliff, his first mistake is likely to be his last. Neither hand nor foot can be moved except with the exercise of sure judgment, and with the nicest precision.

Muir was able to do what he did only by possessing a most wonderful combination of clear eye, unfaltering nerve, and limbs of great strength and endurance. John Muir's books, in the matter of personal safety, are in marked contrast with those of many mountain climbers. One finds danger only occasionally mentioned. In order to appreciate Muir's marvelous, almost uncanny skill as a climber, it is necessary to go to the writings of others who have had the good fortune to see Muir at work. With remarkable speed, unflagging energy, and nerves unshaken, he would climb on dangerous ground for twelve, fourteen or sixteen hours without rest; and on one remarkable occasion when a life was at stake his mountain work extended throughout the night, during which he had not only himself to guide, but to lead and carry his crippled friend over very difficult ground in the darkness.

The same qualities were shown in Muir's glacial work. To explore glaciers alone, and especially unknown glaciers, requires great agility and endurance, constant skill, steady coolness, and never-failing watchfulness. To jump innumerable crevasses, to cross those too wide to jump on ice bridges, are a severe strain upon the nerves of any man; and yet Muir, on one of his trips of exploration, dragging a heavily loaded sled over the rough ice or pushing it ahead of him across the ice

bridges, worked day after day alone on the vast glacier that bears his name.

The man who goes out to the wilds alone is a true lover of nature, not a lip worshiper. The mighty forests are sometimes so soundless that the ear hears only the circulating blood; at other times are a tumultuous mass of tossing boughs, swaying limbs and crashing trunks. In the impenetrable darkness of the forests at night, it is as if the eye did not exist; but the tense ear may catch a myriad mingled sounds—the moaning of the trees, the falling of the waters, and the joyful, weird, or angry cries of fowl and beast. In the day the eye may sweep over the endless plain, leap a hundred miles to the distant mountain peak, or attempt to penetrate the gray mist hanging over the crevasses of the glaciers. To be alone with nature, oppressive and terrifying to the city born, was a delicious pleasure to Muir. Indeed it was with almost delirious joy that he felt himself to be a part of the handiwork of the Almighty. To him cliff, air, cloud, flower, tree, bird and beast—all were manifestations of a unifying God.

The great public service of John Muir was leading the nation through his writings to appreciate the grandeur of our mountains and the beauty and variety of their plant and animal life, and the consequent necessity for holding forever as a heritage for all the people the most precious of these great scenic areas. Probably to his leadership more than to that of any other man is due the adoption of the policy of national parks.

Of a man who is likable, it is a commonplace to say that all who knew him loved him; but this was so intensely true of Muir that one feels he should have a stronger word than love. For his friends, mingled with love, were ardent admiration for his tall, thin, sinewy frame, and almost worship for the inner fire which burned upon his strong and noble face.

The story of Stickeen reveals the adorable qualities of the man as well as the finer qualities of a dog. Here are the impressions of his companion, the missionary Young, to whom Muir told the story of Stickeen after that memorable day and evening upon Taylor Glacier:[10]

Finally Muir broke the silence. "Yon's a brave doggie," he said. Stickeen, who could not yet be induced to eat, responded by a glance of one eye and a feeble pounding of the blanket with his heavy tail.

Then Muir began to talk, and little by little, between sips of coffee, the story of the day was unfolded. Soon memories crowded for utterance, and I listened till midnight, entranced by a succession of vivid descriptions the like of which I have never heard before or since. The fierce music and grandeur of the storm, the expanse of ice with its bewildering crevasses, its mysterious contortions, its solemn voices were made to live before me.

When Muir described his marooning on the narrow island of ice surrounded by fathomless crevasses, with a knife-edged sliver curving deeply "like the cable of a suspension bridge" diagonally across it as the only means of escape, I shuddered at his peril. I held my breath as he told of the terrible risks he ran as he cut his steps down the wall of ice to the bridge's end, knocked off the sharp edge of the sliver, hitched across inch by inch and climbed the still more difficult ascent on the other side.

But when he told of Stickeen's cries of despair at being left on the other side of the crevasse, of his heroic determination at last to do or die, of his careful progress across the sliver as he braced himself against the gusts and dug his little claws into the ice, and of his passionate revulsion to the heights of exultation when, intoxicated by his escape, he became a living whirlwind of joy, flashing about in mad gyrations, shouting and screaming "Saved, saved!" the tears streamed down my face.

It was especially fitting that, in recognition of Muir's great public service to conservation through advancing the movement for the creation of forest reserves and national parks, the University of Wisconsin, many years after his regretful farewell, granted him her highest academic honor, the degree of doctor of laws.

It is indeed fortunate and most appropriate that through the decades and centuries to come, the youth of the university may behold this beautiful bronze bust which has so faithfully caught the thoughtful countenance of Muir, as if in meditation upon the meaning of the

10 "Alaska Days with John Muir," S. Hall Young, pp. 187–88.

order of the universe—which so prolifically creates, which so lavishly destroys, and which through innumerable alternations of life and death in some mysterious way ever climbs to higher things. CHARLES R. VAN HISE

SCIENTIFIC EVENTS

SCHOOL OF THE GENERAL EDUCATION BOARD

DR. OTIS W. CALDWELL, now head of the department of natural sciences in the school of education of the University of Chicago, has been appointed director of a new elementary and secondary school to be established by the General Education Board in connection with Teachers College, Columbia University. The general management will be vested in an administrative committee composed of James E. Russell, dean of Teachers College; Dr. Caldwell, V. Everit Macy, Mrs. Willard D. Straight, Felix M. Warburg, Arthur Turnbull, George E. Vincent, Wickliffe Rose, Charles P. Howland and Abraham Flexner, subject to the authority of Columbia University and Teachers College. The plans contemplate discarding Latin and Greek, which will be replaced in the curriculum by modern languages, French, German and Spanish. Science is to have a more prominent place than in the ordinary school. The school is understood to be planned to carry out the ideas set forth in Dr. Abraham Flexner's essay "The Modern School." The announcement given out by the General Education Board says:

> Organized recreation, play and games will be provided for. Constant efforts will be made by means of individual, class and school excursions, by means of pictures, lantern slides, charts, maps, shop and laboratory, special reading matter, and discussions to give the pupils sufficient contact with their natural, industrial, social, economic, vocational and domestic environment so as to derive the basis for their school work from real situations, and thus make school work constantly real to them. The school will frankly discard that theory of education known as "formal discipline," and will undertake to secure training through the careful and thorough study of subjects which are in themselves valuable. It is believed that a much more effective discipline can be thus secured.

The new school, which will open with part of its classes in the fall of 1917, will admit boys and girls from 6 years of age up. It is stated that tuition fees will be moderate and that there will be free and partly free scholarships.

THE EDWARD L. TRUDEAU FOUNDATION FOR RESEARCH AND TEACHING IN TUBERCULOSIS

AN endowment fund has been created as a memorial to the late Dr. Edward L. Trudeau, to perpetuate his name and to continue the scientific investigations that were a life-long interest of the American pioneer in tuberculosis research. The income is to be devoted to the following purposes:

> 1. To maintain laboratories and carry on research into the nature, causes and treatment of tuberculosis.
>
> 2. To maintain regular courses of instruction for physicians and others in the most advanced knowledge of the above subject, under the name of the Trudeau School of Tuberculosis.
>
> 3. To offer young physicians the opportunity to engage in research work, while undergoing treatment for the disease, through the establishment of fellowships.

The trustees of the Trudeau Sanatorium are to administer this fund, with the aid of an advisory council of distinguished investigators and teachers, consisting of Professor William H. Welch and Professor Theodore C. Janeway, of Johns Hopkins University; Dr. Hermann M. Biggs, New York State commissioner of health; Dr. William H. Park, director of laboratories, New York City Health Department; Professor Theobald Smith, director of the department of animal pathology, Rockefeller Institute; Professor Warfield T. Longcope, Columbia University; Professor Thomas McCrae, Jefferson Medical College, Philadelphia, Pa.; Dr. John H. Lowman, Western Reserve University, Cleveland, O., and Dr. Vincent Y. Bowditch, of Boston.

The plans for researches in tuberculosis are comprehensive in their scope, including the fields of clinical and laboratory experimentation. The scientific study and treatment of this disease under conditions favorable for the continued observation of patients with the best facilities obtainable, will be encouraged in

every way. Clinical and laboratory work will be carried on under experienced direction, with the aim of enlisting the interest of physicians and others in the solution of many problems awaiting study.

The facilities for research are as follows:

1. The Trudeau Sanatorium Medical Department (150 beds), including the Infirmary.
   (a) The Clinical Laboratory.
   (b) The Research Laboratory.
   (c) The X-Ray Laboratory.
   (d) The Statistical Department.
2. The Saranac Laboratory. (In the village of Saranac Lake.)
3. By cooperation with the various tuberculosis sanatoria and hospitals in the vicinity, clinical and laboratory facilities are available in the following institutions:
   (a) The State Sanatorium, Ray Brook, 350 beds.
   (b) The Stony Wold Sanatorium, 150 beds.
   (c) The Gabriels Sanatorium, 70 beds.
   (d) The Reception Hospital, 20 beds.
   (e) The Saint Mary's Hospital, 20 beds.

AWARDS AND PRIZES OF THE PARIS ACADEMY OF SCIENCES

The committee, as we learn from *Nature*, has had to examine thirteen requests for grants from the Bonaparte Fund. The following grants are recommended: (1) Charles Alluard (4,000 francs), for continuing the publication, in conjunction with R. Jeannel, of the scientific results of three expeditions in eastern Africa (1903 to 1912). (2) M. Bondroit (2,000 francs), for collecting the material in France necessary for the constitution of a fauna of French ants. (3) Pierre Lesage (2,500 francs), for the continuation of his experiments on the plants of the coast zone, and in particular his researches on the transmissibility of the characters acquired by plants watered with salt water. (4) The Touring Club de France (3,000 francs), to contribute to the establishment of the new botanic garden at Lautarel (Hautes-Alpes). (5) Camille Sauvageau (3,000 francs), for extending to the species of *Laminaria* of the Mediterranean and the Channel the remarkable discoveries of the author on the development of a single species which grows in the Bay of Biscay. (6) Em. Vigoroux (2,000 francs), to contribute to the purchase of apparatus useful for the continuation of his interesting researches on the state of silicon dissolved in metals. (7) Raoul Bayeux (2,000 francs), to aid him in continuing his researches on the physiological effects and the therapeutics of hypodermic injections of gaseous oxygen. The author proposes to study experimentally the action of hypodermic oxygenation on the defensive reactions of the organism against asphyxia and against infections. (8) Joseph Laïs as a contribution to the expense of photogravures relating to the photographic chart of the heavens, the copper-plates to become the property of the Paris Observatory.

The committee has in reserve, after payment of these grants, 55,000 francs.

Among prizes awarded by the academy were the following:

The Jean Reynaud prize to the late Henri Amagat, for the whole of his work; the Baron de Joest prize to Ernest Esclangon, for his researches on the sound phenomena produced by cannon and projectiles; the Houllevigue prize to Edmond Bordage, for his studies on the fauna and flora of Réunion; the Henri de Parville prize to Auguste Barbey (1,000 francs), Louis Raveneau (500 francs), Daniel Bellet (500 francs), and E. Montoriol (500 francs); the Lonchampt prize to Mlle. Thérèse Robert (2,500 francs), for her researches on the function of calcium salts on the growth of plants, and H. Busquet (1,500 francs), for his physiological and pharmaco-dynamical researches; the Wilde prize to M. Mansuy (2,000 francs) and F. Garrigou (2,000 francs), for the whole of their work; the Camére prize to M. Freyssinet, for his novel applications of reinforced concrete; the Gustave Roux prize to (the late) Michel Longchambon (2,000 francs), for his geological and petrographical work; the Thorlet prize to Adolphe Richard; the Lannelongue foundation between Mmes. Cusco and Rück; the Laplace and Rivot prize is not awarded; the Trémont foundation (1,000 francs) to Charles Frément, for his work on the deformations of metals submitted to stresses: the Gegner foundation to A. Claude

(2,000 francs) and Mlle. I. Iotevko (2,000 francs); the Jérôme Ponti foundation to MM. Battandier and Trabut, for their botanical work in northern Africa.

SCIENTIFIC NOTES AND NEWS

THE French Association for the Advancement of Science, in order to fulfil the provisions of its constitution, held a general assembly at Paris on October 28, when the president, M. Emile Picard, made an address, in which he discussed German and French contributions to science.

SIR ROBERT HADFIELD has been elected president of the Faraday Society, London.

DR. ELLSWORTH HUNTINGTON, of Milton, Mass., has been elected president, and Professor John W. Harshberger, of the University of Pennsylvania, vice-president of the Ecological Society of America.

AT the meeting of the Society of Directors of Physical Education and Colleges, held in New York on December 29, Dr. Joseph E. Raycroft, Princeton, N. J., was elected president.

THE New York State Science Teachers' Association, in convention at Syracuse, chose Professor R. C. Gibbs, of the department of physics of Cornell University, as its president.

DR. BARTON WARREN EVERMANN, director of the Museum of the California Academy of Sciences, has been elected president of the Cooper Ornithological Club.

PROFESSOR ROLLA CLINTON CARPENTER, of Sibley College, Cornell University, has resigned, his resignation to take effect at the end of this academic year. Professor Carpenter will reach the age of sixty-five on June 26, 1917, the day before commencement.

THE National Institute of Social Sciences has awarded medals of the society to Professor M. I. Pupin, of Columbia University, for his work in mathematical physics and electrical engineering; to Surgeon General William C. Gorgas, for his work in stamping out yellow fever in Cuba and Panama, and to Dr. George W. Crile, of Cleveland, for his contributions to surgery and allied sciences.

THE C. M. Warren Committee of the American Academy of Arts and Sciences has made an additional grant of $150 to Professor R. F. Brunel, of Bryn Mawr College, for the continuation of his research on the relation between the constitution of aliphatic radicals and their chemical affinities.

HENRY N. OGDEN, professor of sanitary engineering in the college of civil engineering of Cornell University, has been reappointed a member of the State Public Health Council by Governor Whitman. Professor Ogden was made a member of this council when it was created in 1913. Before that he had been for seven years engineer to the state board of health.

THE Bureau of Fisheries has engaged the services of Dr. N. L. Gardner, of the University of California, for comprehensive investigations of the marine algæ of the Pacific coast, with reference to their more adequate utilization and their relation to fisheries.

PROFESSOR HENRI A. HUS, of the department of biology of the University of Michigan, who was granted a three years' leave of absence for the purpose of doing some experimental work for the United States Rubber Company at their plantation in Sumatra and in the botanical garden at Buitenzorg on the island of Java, has returned to the United States owing to lack of laboratory equipment due to the present war, and will continue his work in the New York Botanical Garden.

WE learn from *Nature* that Mr. F. A. Stockdale, director of agriculture, Mauritius, has been appointed by the British Secretary of State for the Colonies director of agriculture, Ceylon, and Dr. H. A. Tempany, government chemist and superintendent of agriculture for the Leeward Islands, has been appointed to succeed Mr. F. A. Stockdale as director of agriculture, Mauritius.

ON December 25, Dr. Charles L. Parsons, chief chemist of the Bureau of Mines, returned from a ten-weeks' trip in Europe. As a representative of the War Department, Dr. Parsons visited Norway, Sweden, England, France and Italy, to make a study of nitrogen

fixation processes. He was offered unusual opportunities for studying the chemical industries, especially those whose development has resulted from the European war. He also visited the clay deposits and the tin and tin concentration works at Cornwall, England.

PROFESSOR VERNON L. KELLOGG, of Stanford University, continues his work of overseeing the feeding of the Belgian people for another six months. This gives him a year and a half of this work as first assistant to his Stanford colleague, Herbert Clark Hoover.

DR. G. H. A. CLOWES, director of the Gratwick Research Laboratory, spoke on "Colloidal Equilibrium" at the meeting of the Indiana Section of the American Chemical Society on December 8. Dr. Wilder D. Bancroft will address the Indiana Section on March 9, and Dr. E. V. McCollum on May 11.

DR. IRA N. HOLLIS, president of the American Society of Mechanical Engineers, visited the University of Illinois last week, to give an address to the faculty and students in the college of engineering, on the subject of "The Relation of Efficiency to Democracy."

PROFESSOR DOUGLAS W. JOHNSON, of Columbia University, addressed the American Philosophical Society on January 5, on the subject, "The Strategic Geography of the Balkan Campaign."

THE death has occurred at his home in New Rochelle, N. Y., of Henry Gordon Stott, past president of the American Institute of Electrical Engineers and of the American Society of Mechanical Engineers. He was born in the Orkney Islands in 1866.

ROBERDEAU BUCHANNAN, computer in the U. S. Naval Observatory from 1879 to 1910, the author of works on mathematics, astronomy and genealogy, died on December 18, at the age of seventy-seven years.

THE REV. BROTHER CHRYSOSTOM (Joseph J. Conlen), professor of philosophy and psychology at Manhattan College, died on January 24, aged fifty-four years.

MR. JUAN J. RODRIGUEZ, of Guatemala City, Guatemala, died on December 22, aged seventy-five years. Mr. Rodriguez for many years studied and collected the fauna of Guatemala, and was well known to naturalists as the discoverer of many new and interesting species.

MR. WILLIAM MARRIOT, for forty-three years assistant secretary of the British Meteorological Society and for thirty years editor of the *Meteorological Record,* died on December 28, at the age of sixty-eight years.

SIR EDWARD BURNETT TYLOR, Hon. D.C.L., M.A., formerly keeper of the Oxford University Museum, professor and reader in anthropology and professor emeritus, died at Wellington, Somerset, on January 2.

CAPTAIN F. C. SELOUS, known for his zoological explorations in Africa, has been killed in action in East Africa, aged sixty-five years.

SIR E. B. TYLOR, professor emeritus of anthropology in the University of Oxford, distinguished for his publications in ethnology, died on January 2, at the age of eighty-four years.

DR. J. LITTLE, Regius professor of physic, Dublin University, has died in his eightieth year.

DR. B. R. POPPIUS, the Finnish entomologist, died on November 27 at the age of forty years.

UNIVERSITY AND EDUCATIONAL NEWS

A BILL has been introduced into the state legislature of Arkansas providing a half-mill tax for the University of Arkansas. The bill has been recommended by the trustees of the university and approved by the governor.

Two industrial fellowships for the chemistry of indiarubber have been established in the University of Akron, provided by the Goodyear Tire and Rubber Company and the Firestone Tire and Rubber Company. These fellowships are of the value of $300, and the holder may subsequently enter the employ of the company.

THE building of the Hunterian Laboratory of the Johns Hopkins Medical School, completed at the cost of $115,000, has now been opened. According to the *Journal* of the American Medical Association, the building is connected by tunnels with the medical school and

the physiological building. On the first floor are the medical library and the department of art as applied to medicine. Work at the laboratory is directed by a committee of professors and instructors of the medical school. Dr. Milton C. Winternitz is chairman of the committee, and has a laboratory on the fourth floor. The second floor has been leased to the Carnegie Embryological Institute. The third floor will be devoted to work in clinical medicine and children's diseases and the fourth floor to the pathological department.

DISCUSSION AND CORRESPONDENCE

NOTICE OF POSSIBLE SUSPENSION OF THE RULES OF NOMENCLATURE IN THE CASES OF HOLOTHURIA 1758 VS. PHYSALIA 1801, AND BOHADSCHIA 1833 VS. HOLOTHURIA 1791

In accordance with the requirements prescribed by the International Congress of Zoology, notice to the zoological profession is hereby given that on or about October 1, 1917, the undersigned proposes to recommend to the International Commission on Zoological Nomenclature that the rules be suspended in the following cases:

Holothuria Linn., 1758 (type *physalis*), *vs.* *Physalia* Lamarck, 1801 (type *pelagica*). The effect of suspension will be to retain *Physalia* as generic name for the Portugese man of war.

Bohadschia Jaeger, 1833, *vs.* *Holothuria* Bruguière, 1791. The effect of the suspension will be to retain *Holothuria* for the sea cucumbers.

The motion for suspension includes the following points:

1. Suspend the rules in the case of the generic names in question;
2. Permanently reject *Holothuria* 1758, type *physalis;*
3. Validate *Physalia* 1801, type *pelagica* (syn. *physalis* 1758);
4. Accept *Holothuria* as dating from Bruguière, 1791, despite the existence of *Holothuria* 1758 (if rejected);
5. Said suspension is not to be construed as invalidating any specific name.

The grounds advanced for suspension will be:

(*a*) A strict application of the rules in these cases will result in greater confusion than uniformity, because

(*b*) The cases involve a transfer of generic names, almost universally accepted in the sense given above since 1791 (for *Holothuria*) and since 1801 (for *Physalia*), to genera in other groups in connection with which they have been used by only a very few authors during more than 100 years.

The undersigned cordially invites zoologists to communicate, not later than September 1, 1917, to him or to any other member of the commission, either their approval or disapproval of the proposed action.

C. W. STILES,
Secretary to Commission

DO THE FOWLER'S TOAD AND THE AMERICAN TOAD INTERBREED?

NOTING a communication under "Discussion and Correspondence" on pages 463 and 464, of the September 29, 1916, issue of SCIENCE, as regards the song of *Bufo fowleri* Putn., I would say that in over fifteen years of experience as observer and student of Amphibians, I have never been able *positively* to trace the clear, trilled song, lasting from 10 to 30 seconds, to any but the American toad, *Bufo americanus* Le Conte. In any large collection of both species, where both occur together, there are individuals which seem to combine the external characteristics of both species. In the study collection of the American Museum of Natural History, New York City, there are, for instance, a number of toads which at first glance would be identified as *Bufo americanus*. They have the large kidney-shaped parotoids, divergent cranial crests, spotted belly of *B. americanus*, but also the short, abrupt profile, proportionally narrow head, and much finer texture of skin, especially that of the belly, of *B. fowleri*. The color pattern alone can not always be relied upon, as *B. americanus* often has the narrow median pale line, the distinct black spots arranged in longitudinal rows, sometimes confluent. and the peculiar greenish gray ground color, of *B. fowleri*, and vice versa, *B. fowleri* has sometimes the reddish brown ground color, with indistinct vertebral streak and but few

scattered black spots and spotted undersides of *B. americanus*. All this, in conjunction with Mr. H. A. Allard's notes and observations, would lead one to believe that both species are closely related, and that they possibly interbreed occasionally, these forms with the characteristic marks, etc., of both species representing the hybrids.

In conclusion I will state that the typical *B. americanus* and the typical *B. fowleri* differ in the following characters, based on examination of hundreds of specimens, covering a period of ten or more years:

Bufo americanus Le Conte

1. Head broad, profile sloping towards tip of snout.
2. Cranial crests always diverging from the nostrils.
3. Skin covered with comparatively large round warts, often arranged in rows or groups, the former on the back, the latter on hind limbs. The undersides are more or less granular. The larger warts often have spiny tips, especially in large females.
4. The legs are stout, and moderately long, the foot large and thick, the fingers rather short and thick.

Bufo fowleri Putnam

1. Head narrow, very thick, profile abruptly rounded towards the tip of the snout.
2. Cranial crests sometimes parallel, often fused in the midline, forming a distinct lump between the eyes. This never occurs in *B. americanus*.
3. Skin finely granular above, with groups of larger warts. These warts are *never* spiny in this species. The under sides are either very finely granular or entirely smooth.
4. The legs are longer, in proportion to the body, than of *B. americanus*, the foot is rather delicate, fingers and toes are long and slender.

Richard Deckert

N. Y. Zoological Park,
New York City

THE POPULAR NAMES OF NORTH AMERICAN PLANTS

To the Editor of Science: In the course of our work here, considerable numbers of plants are frequently sent in by teachers to be named, and doubtless many similar requests for information are received by the officers of the provincial governments and the experiment stations throughout the United States. In replying to such enquiries the Latin name of the species is always given and the English name where such exists. It is clear, however, that pupils in the public schools, as well as many of their teachers, do not and can not reasonably be expected to take any interest in or to remember the Latin names of plants. This being so, it is highly desirable that every species of plant inhabiting the United States or Canada should have an English name. It is further desirable that the name should not be a local one, but should be applicable to the plant wherever it is found, from the Atlantic to the Pacific ocean. If possible, the name should be such as to distinguish the plant from allied species, the name being based on some structural character such as height, hairiness, color of flowers, etc.; or on the habitat, such as marsh, mountain, wood, etc.; or on its use in the service of man, Indian names when such exist being adopted.

Where different genera have the same English name, some qualifying word will be specially necessary. For example, fireweed may mean either *Erechtitcs hieracifolia* Raf., or *Epilobium angustifolium* L. This ambiguity would be removed by calling the former white fireweed and the latter purple fireweed.

In order that each species of plant may have an English name, it would be necessary to draw up a list of the species inhabiting the United States and Canada, and it seems to the present writer that in drawing up such a list a very wide interpretation should be given to the meaning of the term species. At the present rate of progress, it will be many years before the "North American Flora"—the standard work on the subject for this continent—will be completed, and discussion as to the limits of so-called species may be expected to continue for a much longer period. Consequently, a provisional list should be issued, no attempt being made to define the limits of a species in too critical a manner, the popular English names not being suited for such fine distinctions. The common English name should be applied to aggregate rather than segregate species. For example, pipsissewa or prince's

pine should be regarded as applicable to either *Chimaphila corymbosa* Pursh., or *C. occidentalis* Rydb., the two species into which *C. umbellata* Nutt. has been split up in the "North American Flora."

There is, of course, room for discussion as to the best method of procedure to adopt. Many botanists—especially those who are never called on to name plants for the general public—are quite satisfied with the Latin names alone, and from them in all probability no assistance can be expected in devising English names. The subject is one that might well be discussed at some conference of American botanists, as it mainly concerns ourselves alone.

J. Adams

Central Experimental Farm,
Ottawa, Canada,
November 21, 1916

PROPULSION BY SURFACE TENSION

To the Editor of Science: In November, 1911, I described in your columns a little motor boat which I supposed to be novel. A wooden boat only a couple of inches long, was provided with a stern consisting of a slab of soap, and when placed on clean still water moved about with noticeable rapidity.

I have just learned that M. Henri Devaux constructed an absolutely equivalent craft many years ago (*La Nature,* April 21, 1888). His boat was made of tinfoil and the "propeller" was a scrap of camphor attached to the stern.

Pray allow me to tender to M. Devaux my apologies and compliments.

George F. Becker

SCIENTIFIC BOOKS

A Sylow Factor Table of the First Twelve Thousand Numbers. By Henry Walter Stager. Carnegie Institution of Washington, 1916. Pp. xii + 119.

Dr. Stager's tables are intended to furnish the possible number of Sylow subgroups for all groups whose order does not exceed 12,000. For every number within that limit are listed all the divisors which are of the form $p(kp+1)$, where p is a prime greater than 2 and k is greater than zero. In determining the possible number of Sylow subgroups such divisors must be known before further methods are applicable. Thus from the table we learn that 1,080 is divisible by $3(1\times 3+1)$, $3(3\times 3+1)$, $3(13\times 3+1)$, $5(1\times 5+1)$, $5(7\times 5+1)$ and $5(43\times 5+1)$. From these results we know that for a group of order 1,080 there may be 1, 4, 10 or 40 subgroups of order 3^3 and 1, 6, 36 or 286 subgroups of order 5. The exact number is to be determined by other principles of group theory. The table also gives the expression of each number up to that limit as products of powers of primes.

The making of tables, a tedious and apparently mechanical task, is of the highest importance in all branches of science. It is likely that more fundamental theorems have been discovered by the examination of listed results than by any other means. This is certainly true in the theory of numbers, and it is possible that workers in the theory of groups have not made enough use of this method of investigation. The construction of tables for the theory of groups is especially difficult on account of the great complexity of the material. Only brief tables have hitherto been undertaken and it is to be hoped that Dr. Stager's work in this direction may be the beginning of a systematic campaign in this important field.

The construction of an extensive table almost always brings to light hidden relations, suggesting new theorems for investigation. In Dr. Stager's table certain numbers are noted which have no divisors of the sort indicated above. Such numbers seem to resemble primes in many ways, and in particular their "curve of frequency" seems to run roughly parallel to the corresponding curve for primes. Dr. Stager has made a study of these numbers, and has added a list of them up to the limit of his table.

The author is to be congratulated upon the completion of so important and formidable a piece of work. While the reviewer has, of course, not checked over any part of the table he has the utmost confidence in the accuracy of the list. The printing has been done by the

photographic methods employed by the Carnegie Institution in the publication of the Factor Tables and the List of Primes. Both the author and the publishers deserve the gratitude of every lover of science in putting in the hands of mathematicians results of such permanent value. D. N. LEHMER

UNIVERSITY OF CALIFORNIA

Feeding the Family. By MARY SWARTZ ROSE. New York: The Macmillan Company, 1916. Pp. xvii + 449, illustrated.

Many factors contribute to the welcome such a book as this will doubtless receive. World conditions are forcing a searching analysis of food supplies. Any discussion of the subject, however, whether for the purpose of conserving existing supplies by reducing waste or of increasing the supply by stimulating production, must be based on an understanding of the relation between food materials and bodily needs, for the food requirement of 10,000,000 families is but a simple multiple of the food requirement of one family. There is a growing disposition, too, among those who set for themselves serious tasks in life to be restive under small ailments which curtail working hours and reduce efficiency. There is a demand, therefore, for a working knowledge of personal hygiene, including simple, rational, well-founded rules for eating. At the same time great new avenues for instruction are opening and home economics, including the subject of foods, is being introduced in places undreamed of a few years ago. It has been made part of the instruction in universities and primary schools and is being taught in remote mountain regions by extension methods and in crowded city tenements by visiting housekeepers. This is creating a demand among instructors for reliable handbooks. At the same time it is creating a great body of intelligent housekeepers in private homes and in public institutions who are ready and anxious to make those fine adjustments between food supplies and family needs without which nation-wide or world-wide campaigns for the conservation of food must be largely ineffective.

Those who approach the subject most intelligently often find that they must use one language—that of calories and protein—in discussing bodily needs, and another—that of bread and butter, or bacon and eggs—in planning meals or in buying food. Only the fortunate few who, of course, include the writer of the book, use both languages with equal facility. Most people need two-part dictionaries of food, by means of which they can change from the language of calories and protein to the language of bread and butter, and back again, if necessary. Such dictionaries are, to be sure, not entirely new. Many books have given 100-calorie portions in terms of common food materials and have recorded in convenient form the food values of many common dishes. Years ago Mrs. Richards put much of this material into chart form for use in the kitchen. The time, however, was not ripe then for such information and the plans were never much elaborated. Now to meet new needs Mrs. Rose has presented a large number of carefully worked-out tables, the fruit of years of study and of teaching. By use of them the reader finds not only the weight, but also the volume, of common foods that it requires to furnish a definite amount of nourishment. We find, for example, not only that it requires 2½ ounces of creamed salt codfish, made after a recipe given in the book, to provide 100 calories of energy and that 32 of the calories would be supplied by protein, but also, what is of even greater value to the housekeeper, that this amount would measure about one-half of a cup. Again we find that a familiar recipe for cottage pudding would make two loaves, 6 by 4 by 1¾ inches in size; that it would weigh 24.3 ounces; that it would supply 2,100 calories; and that a 100-calorie portion would be a slice 1¾ by 2 by 2½ inches in size. In general, every provision is made for adjusting food supply to food requirement.

The food requirements of persons of different ages and occupation are carefully presented, and family dietaries are worked out.

The subject of prices is subordinated to that of food values. This is fortunate, for food values are permanent while prices fluctuate

with seasons or years or markets. It is often necessary for the sake of clearness of presentation to deal with prices, but the general futility of doing so is demonstrated by the fact that even at the moment when this book was published prices differed widely from those reported in the chapters on the cost of food. This shows the need of thorough education in food values and we might almost say of training in arithmetic, which will enable one to see the money relations of food for oneself and to compare costs as prices change.

The important but often neglected subject of food prejudices is most happily treated in "Food for Children Eight to Twelve Years Old."

As Mrs. Rose points out, "only a few well-chosen dishes need be offered at any one meal, but a tendency to choose a single dish for a meal and refuse everything else should be discouraged. In adult life a well-balanced diet demands more kinds of food than in childhood, when such a variety of elements is supplied by milk alone, and it is a great advantage to have been so trained as to be able to take these in all sorts of forms. Most adults eat in groups and pronounced individual likes and dislikes have great economic and social, if not always physiological, disadvantages. Half the problems of the food provider arise, not from the difficulty of securing wholesome food to make a well-balanced ration, but from the necessity of remembering that . . . [individual tastes vary]. Youth is the time to cultivate respect for all natural foods as a means to physical and mental efficiency, and not merely as ticklers of the palate. . . . Most food aversions are acquired in early life when the sensibilities are keenest. An accident at the table with humiliating consequences, an unpleasant association of a food with illness, a comparison with something disagreeable, may cause repugnance lasting for years. Such aversions, once acquired, call for patience and tact and may never be completely overcome. . . . It is worth while to take thought as to how to keep children's attitude toward their food rational."

C. F. Langworthy

RECENT PROGRESS IN PALEONTOLOGY

Invertebrates.—Owing to disturbed international conditions, the number of foreign contributions to the literature of paleontology is almost negligible. In this country the most important work on the invertebrate division of the science is contained in the two volumes on the Upper Cretaceous of Maryland, published by the geological survey of that state. It is illustrated by a handsome series of plates.

Dr. C. D. Walcott, in continuation of his studies of Cambrian geology and paleontology, has published the third of a series of papers that bears the title of "Cambrian Trilobites" (*Smithson. Misc. Coll.,* Pub. No. 2420). It is accompanied by 23 excellent plates. In the *Proceedings of the U. S. National Museum* Professor T. D. A. Cockerell has two papers on American and British fossil insects. In Bulletin 96 of the same institution Dr. R. S. Bassler and Ferdinand Canu have published a "Synopsis of American Early Tertiary Cheilostome Bryozoa." Dr. A. F. Foerste is author of an important memoir on the Upper Ordovician formations in Ontario and Quebec, published by the Canadian Geological Survey. Some new Silurian brachiopods from Maine are made known by H. S. Williams, and new Oligocene mollusks from Georgia are described by W. H. Dall, both papers contained in the *Proceedings of the U. S. National Museum.*

Fishes.—Some new anatomical features regarding the peculiar arthrodiran genus *Homosteus* are described by Dr. A. S. Woodward in the *Journal of the Torquay Natural History Society.* New investigations on British Paleozoic ganoids and lung-fishes have been conducted by Dr. D. M. S. Watson and Henry Day (*Mem. and Proc. Manchester Lit. and Phil. Soc.,* Vol. 60, pt. 1), and the latter author has also issued a note on the parasphenoid of a Palæoniscid (*Ann. Mag. Nat. Hist.,* Vol. 16, pp. 421–434).

The remarkable spirally coiled dental organs of *Helicoprion,* from the Permian of Russia, form the subject of two communications by A. Karpinsky, the original discoverer of these re-

mains. A new species, *H. clerci,* is described by him from the Artinsk beds. The reference of this genus to the Cestraciont group of sharks seems now fully warranted. Dr. A. S. Woodward (*Nature,* Vol. 98, pp. 163–164) has also discovered evidence which substantiates the view that the segmented structures known as *Edestus* form the symphysial series of the dentition belonging to *Campodus-* or *Orodus-*like sharks.

Italian science suffered an irreparable loss in the death last April of Professor Francesco Bassani, of Naples. A fine tribute to his memory, with a list of his numerous papers on fossil fishes and other subjects, has recently been published by his colleague Geremia D'Erasmo, and another by G. de Lorenzo.

Comparatively little has been added to our knowledge of fossil fishes from North America during the year. Dr. L. M. Lambe has described a few ganoids from the strata of Lower Triassic age near Banff, Alberta (*Trans. Roy. Soc. Canada,* Vol. 10), and others from the Coal Measures of Linton, Ohio, have been investigated by L. Hussakof (*Bull. Amer. Mus. Nat. Hist.,* Vol. 35). A report upon the collection of fossil fishes contained in the U. S. National Museum has recently been published by C. R. Eastman (*Proc. U. S. Nat. Mus.,* Vol. 52). It includes descriptions of a number of new species.

An indispensable reference work which brings together the titles of all publications on the subject of fishes, living and fossil, including their anatomy, physiology, embryology and systematic relationships, is the newly published Bibliography of Fishes, by Dr. Bashford Dean. The collection of the titles for the authors' volume of this work is the result of twenty-five years' unremitting labor. [C. R. E.]

Amphibians and Reptiles.—Dr. R. S. Moodie's important monograph[1] on the Coal Measures Amphibia of North America adequately summarizes and illustrates the numerous and highly varied types of the oldest well-known land-living vertebrates, which are first foreshadowed by a single footprint from the Upper Devonian of Pennsylvania. The amphibians of the Carboniferous age were mostly swamp-living forms embracing small newt-like and serpentiform types; there were also larger animals related to the Labyrinthodonts of succeeding ages.

The amphibians and reptiles of the "Red Beds" of Texas, New Mexico and elsewhere are very fully discussed in a monograph by Professor E. C. Case.[2] After describing the geography and environments of Permo-Carboniferous times the author gives an extended analysis of the fauna, in which he discusses the food supply and food habits, as well as the terrestrial and aquatic adaptations, of these animals. A majority of the forms were partly aquatic and more or less raptorial and carnivorous, but some fed upon insects, others upon mollusks, and others to some extent upon plants. The author discusses the conflict between the defensively and offensively armed types and shows that many of the amphibians and reptiles were so overspecialized that they became extinct at the end of this period. Two of the reptilian families and one type of amphibians developed excessively long spines on the back which the author believes to have been useless to these animals. He suggests that owing to the abundance of the food supply and to the perfection of the weapons of offense, the surplus vitality thus generated was used in the continued elaboration of certain structures, which were possibly useful in their inception, but finally became elements of weakness, and led to the extinction of the group. The monograph is accompanied by many restorations of these animals, by full faunal lists and by a welcome discussion of the classification.

Professor S. W. Williston also continues his investigations of American Permian vertebrates.[3] He gives first a full description of the skull of *Pantylus,* a cotylosaurian reptile which retains a very primitive skull-pattern, and secondly an invaluable and well-illustrated synopsis of the whole fauna of Permian amphibians and reptiles. These forms con-

1 Carnegie Inst., Washington, 1916, Pub. No. 238.

2 Carnegie Inst., Washington, 1915, Pub. No. 207.

3 *Contr. Walker Museum,* Vol. 1, No. 9, pp. 165–236. Chicago, 1916.

tinue to yield many facts of great morphological interest. For example, the author holds that the almost universally accepted view of the origin of the sternum or breast-bone from the fusion of the distal and ventral ends of dorsal ribs in the mid-line is quite incorrect and that the conditions in the early vertebrates prove conclusively that the sternum has been derived rather through the fusion of the "ventral ribs," or gastralia, which were not cartilaginous, but dermal bones, arranged originally in many rows of small rhomboidal ossicles.

Morphological interest is also predominant in Mr. D. M. S. Watson's description[4] of the brain-case in *Eryops* and other Permian types which had an extremely low and primitive type of brain and inner ear. New Permian amphibians and reptiles of South Africa are described in a series of papers from the Transvaal Museum by Dr. Van Hoepen,[5] and from the South African Museum by Mr. S. H. Haughton.[6] The amphibians include most of the groups found also in the Permian of North America. *Myriodon* and *Rhinesuchus*, which are allied to the American *Eryops*, are represented by nearly complete skeletons.

Lieutenant R. Broom continues his description[7] of South African Triassic amphibian specimens in the British Museum. He also describes several new anomodont reptiles.

Two thecodont reptiles of South Africa are described, respectively, by Dr. Van Hoepen[8] and Mr. Haughton.[9] Of these *Sphenosuchus* is a primitive reptile remotely allied to the ancestors of the Phytosaurs, Dinosaurs and other reptiles with two temporal arches.

Several new Phytosaurs of the Trias of Texas and adjoining states are described by M. G. Mehl.[10] Of these long-snouted, gavial-like forms, *Machæroprosopus* and *Angistirhinus* are represented by very good skulls. The same author has discovered an ancestor of the South American caiman in the Oligocene of South Dakota.[11]

Among the sauropod dinosaurs, Dr. Holland[12] has briefly described a new species, *Apatosarus louisæ*, discovered in the great quarry near Jensen, Utah, from which the Carnegie Museum has recovered a very important series of dinosaur skeletons.

Mr. Barnum Brown continues his descriptions[13] of the varied dinosaur fauna of the Cretaceous of Alberta, describing several new types of duck-bill dinosaurs, one of which is ancestral to the crested dinosaur *Saurolophus*. The same author describes a remarkably well-preserved skeleton of another crested dinosaur which had a high skull crest resembling that of a cassowary. Some notes on the marine Triassic reptilian fauna of Spitzbergen are contributed by Carl Wiman in a paper recently published by the University of California.[14] [W. K. G.]

Birds.—A preliminary notice of a nearly complete skeleton of a gigantic fossil bird allied to *Diatryma* from the Lower Eocene is contributed by W. D. Matthew to the *American Museum Journal* for November of this year. It was a contemporary of the well-known four-toed horse *Eohippus* and comes from the same formation in Wyoming. It equalled the moas of New Zealand in bulk, but had a gigantic head with enormous compressed beak like the South American fossil bird *Phororhachos*. A further description of this remarkable creature, together with its probable relations to other extinct avian groups, was presented by Dr. Matthew and Mr. Granger before the December meeting of the Paleontological Society.

Dr. R. W. Shufeldt has reviewed our knowledge of the primitive Eocene genus *Gallinuloides*, and describes a new anserine form,

[4] *Bull. Amer. Mus. Nat. Hist.*, Vol. 35, pp. 611–636.

[5] *Ann. Transvaal Mus.*, Vol. 5, No. 2, pp. 125–149.

[6] *Ann. South African Mus.*, Vol. 12, p. 65.

[7] *Proc. Zool. Soc. London*, 1916, pp. 355–368.

[8] *Ann. Transvaal Mus.*, Vol. 5, No. 1, p. 83.

[9] *Ibid.*, p. 98.

[10] *Bull. Univ. Oklahoma*, Ser. 5, pp. 5 and 26; *Jour. Geol.*, Vol. 23, No. 2, Feb.-March.

[11] *Jour. Geol.*, Vol. 24, No. 1, Jan.-Feb., p. 47.

[12] *Ann. Carnegie Mus.*, Vol. 10, pp. 143–145.

[13] *Bull. Amer. Mus. Nat. Hist.*, Vol. 35, pp. 709–716. *Ibid.*, pp. 701–708.

[14] *Bull. Dept. Geol.*, Vol. 10, No. 5.

Palæochenöides, from the Miocene of South Carolina.[15] He also contributes an extensive account of fossil birds' eggs.[16] [C. R. E.]

Mammals.—Dr. W. K. Gregory[17] has continued his researches upon the evolution of the Primates. In a preliminary discussion of the theory of trituberculy, he shows that the tritubercular molar is the primitive type for Primates as for other Mammalia, and discusses the origin of this type of tooth. He then reviews critically what is known of fossil Anthropoidea and discusses their relationships to man and to the existing anthropoid apes. The shortening of the face and reduction of the front teeth in man he regards as an adaptation mainly to predaceous habits and a carnivorous diet replacing the primitive fruit-eating adaptation of his anthropoid ancestors. This is necessarily associated with the exclusive use of the hands and of weapons for attacking and dividing the prey, in contrast with the use of the teeth for those purposes among the Carnivora.

In his discussion of the phylogeny Dr. Gregory combats strongly the tendency of several recent authors to carry the divergence between the human and anthropoid stems far back into geologic time. He considers "that the Upper Miocene ancestors of the Hominidæ were at least very closely akin to the Upper Miocene common ancestors of the chimpanzee and gorilla, and that they were in fact heavy-jawed, stout-limbed, tailless and semi-erect anthropoid Catarrhinæ, with quadritubercular second and third upper molars and *Sivapithecus*-like lower molars." Nor does he regard the Neanderthal man as wholly excluded from the direct ancestry of the higher races. Dr. Gregory's paper is a notable contribution to the literature dealing with the ancestry of man.

Of high importance likewise is Stehlin's revision of the Eocene Primates of Europe,[18] now completed. The author gives an extended and well-illustrated description of the genera hitherto known, and adds a number of new forms, the most interesting of which are the Chiromyoidea, resembling the modern aye-aye (*Chiromys*) in the rodent-like front teeth, and in the author's opinion related to this group of lemurs. All of the Primates of the European Eocene are in the lemuroid stage of evolution, but their more exact affinities are regarded as very doubtful.

Dr. George F. Kunz's new book, "Ivory and the Elephant," includes a very full and interesting compilation of what is known concerning fossil proboscideans and the evolutionary history of the order, especially as to recent discoveries and opinions.

The discovery of Eocene Mammalia in Burma by Pilgrim and Cotter[19] is of great interest as affording the first direct evidence upon the early Tertiary Mammalia of Asia. The bulk of the fauna consists of primitive anthracotheres which may well be regarded as representing the ancestral group from which the ruminants are derived. This confirms the forecasts of Stehlin, Matthew and others as to the place of origin of the ruminants.

Mr. H. E. Anthony's discovery of numerous well-preserved fossil mammals in a cave in Porto Rico[20] is of remarkable interest. The fauna thus far found consists of a small ground-sloth related to one of the smaller Cuban genera, two or more new genera of rodents rather distantly related to the South American hystricomorphs, and an insectivore of a wholly new family, very remotely related to the continental forms, and lizards not yet studied. This evidence when carefully weighed will have an important bearing on the geographic relations of Porto Rico to other West Indian islands and to the mainland. As far as appears at present, it indicates a prolonged isolation and the ultimate derivation of the fauna rather from Central America by way

15 *Geol. Mag.*, Vol. 3, August, pp. 343–347.

16 *The Emu*, Vol. 16, pp. 80–91.

17 *Bull. Amer. Mus. Nat. Hist.*, Vol. 35, pp. 239–355.

18 *Abh. Schweiz. Palæont. Gesell.*, 1916, Vol. 41, pp. 1299–1552, 2 pls. and 82 text figs.

19 *Records Geol. Surv. India*, Vol. 47, pp. 42–77, 6 pls.

20 *Annals N. Y. Acad. Sci.*, Vol. 27, pp. 193–203, 7 pls. See also Allen, J. A., *ibid.*, pp. 17–22, 4 pls. Later descriptions covering more extensive material in press at time of writing.

of Cuba than from South America by way of the Lesser Antilles; certainly not from North America. But it seems doubtful whether any former continental connection is indicated, the mammalian fauna, like that of Cuba, etc., being limited to a few groups which can be accounted for in other ways.

Mr. E. L. Troxell[21] describes the skeleton of a Pliocene horse which is in many respects intermediate between the three-toed horses of the Miocene and the true *Equus* of the Pleistocene. It is referred to the genus *Pliohippus,* but is much more complete and more truly intermediate in character than the type species described many years ago by Marsh. A second and more complete skeleton has recently been discovered in western Nebraska; both are in the American Museum in New York. [W. D. M.]

C. R. EASTMAN,
W. K. GREGORY,
W. D. MATTHEW

SPECIAL ARTICLES

THE REFLECTION OF γ-RAYS BY CRYSTALS[1]

RUTHERFORD and Andrade[2] have shown that when γ-rays fall on the faces of crystals at certain angles regular reflection takes place as in the experiments of Bragg[3] with X-rays. This should show itself by an increase of absorption of the γ-rays, and in the experiments to be described evidence has been obtained of this character.

A fine pencil of γ-rays passed through a vessel containing a crystalline substance into an ionization chamber where the ionization was measured. The crystalline structure of the absorber was then destroyed either by powdering, melting or by dissolving in water, and any change in the ionization current was measured by a balance method. The change in the ionization gives a measure of the radiation which is reflected from the crystals at such an angle with the direction of the beam as not to enter the ionization chamber. The experimental arrangement is shown in Fig. 1.

The small thin glass crystallizing dish *D,* containing the crystals under investigation was placed over a hole in the lead block *L* so as to rest either directly on the lead block or on an adjustable iron-gauze shelf above it. The γ-rays from the source *S* passed through the crystals and hole, which was 1.2 cm. in diameter, and through a very thin sheet of aluminum foil into the ionization chamber *A*. The balance chamber *B* also received γ-rays from the source through a thick adjustable lead slit *R*. Electrodes passing into *A* and *B* through earthed guard rings were connected to a Wilson-Kaye electroscope *E*. The chambers *A* and *B* were hollow brass cylinders 15 cm. long and 8 cm. in diameter. They were insulated and connected to — 200 volts and + 200 volts, respectively. By means of the key *K* the gold leaf could be earthed or joined to a divided megohm in series with a storage battery for the purpose of measuring the sensibility of the leaf. The leads to the electroscope from the chambers *A* and *B* were completely shielded by brass tubing and lead foil earth connected, so that electrostatic effects were eliminated. The balance chamber *B* was surrounded by a lead sheet 3 mm. thick to prevent any soft scattered radiation from entering it, and all connections to the electroscope were shielded as much as possible from direct radiation by thick blocks of lead. The lead block *L* was 7.5 cm. thick, and for the position of the source used in most of the experiments about twenty-five times as much ionization was produced by the rays passing through the hole as through the rest of the block.

Owing to their short wave-lengths the angles of reflection for γ-rays are probably small. It is, therefore, necessary to use a small cone of

[21] *Amer. Jour. Sci.,* Vol. 42, pp. 335–348, 7 text figs.

[1] This article was written in April, 1914, and describes some experiments performed in Professor Sir Ernest Rutherford's laboratory at the University of Manchester. At that time Rutherford and Andrade were working on the same problem by the more direct method. While the results recorded in this paper have apparently little quantitative value, the general method of attack may be of sufficient interest to justify their publication.

[2] Rutherford and Andrade, *Phil. Mag.,* May, 1914, p. 854.

[3] Bragg, *Phil. Mag.,* May, 1914, p. 881.

rays from a strong source and to work at high sensibility. The sensibility used in the different experiments was varied between 125 and 50 divisions per volt and was measured after each reading of the electroscope.

With the crystals in position a balance was obtained between the two ionization currents in the two chambers. Any change in absorption would then be shown by a corresponding motion of the leaf of the electroscope. In practise it was found unwise to attempt to adjust the balance very accurately when using strong γ-ray sources, since small fluctuations appeared in the movement of the leaf, possibly due to the Schweidler effect.

EXPERIMENTS WITH POWDERED CRYSTALS

The crystallizing dish was filled with the crystals of a given material and placed as shown in Fig. 1. The lead slit was then adjusted until a small leak was observed in the electroscope and the average of a number of readings taken. The crystals were then reduced to a fine powder in a mortar and this powder pressed down in the dish to produce the same thickness of layer as in crystal form. The leak was then read as before.

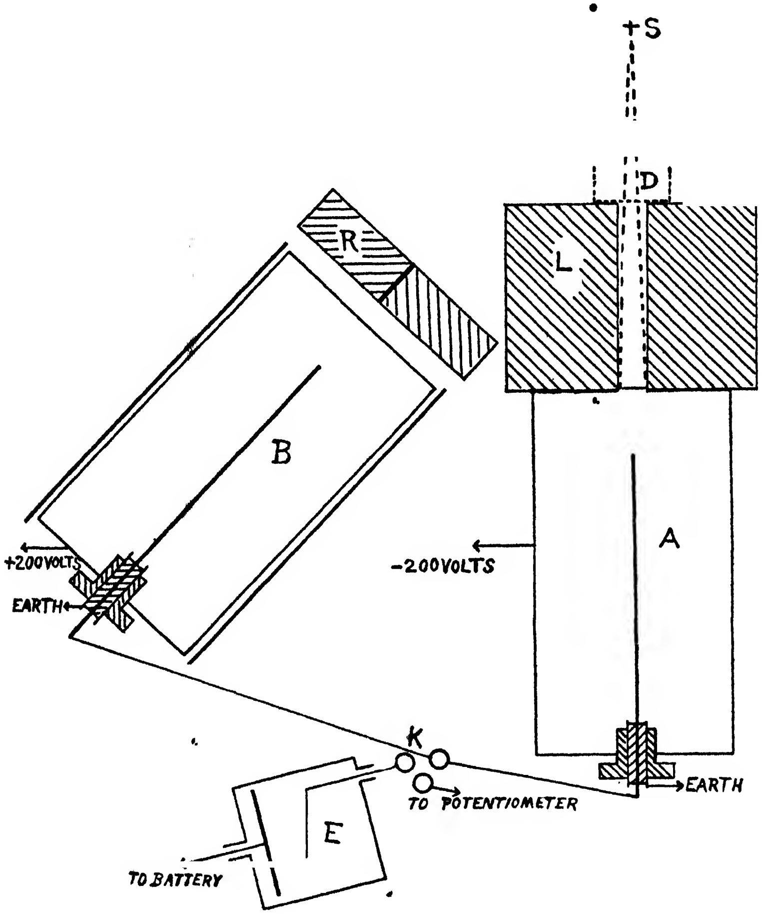

Fig. 1

A decrease in absorption corresponding to a diminution in reflection in general took place. In most of the experiments a 14 mg. radium standard was used as source of γ-rays. A

TABLE I

Position of Crystals	Leak in Div. per Min. Max. Size 1.5 × .5 Cm.	Leak in Div. per Min. Max. Size .5 × .5 Cm.	Leak in Div. per Min. Powdered	Max. Change Due to Absorption	Percentage of Cone Absorbed
On lead block....	27.5, 30.4, 31.8, 29.8 } mean 29.9	25.6, 25.5, 25.7 } mean 25.6	20.4, 21.7 } mean 21.1	8.8	2.3
5 cm. above lead block..	14.5, 13.5, 13.6 } mean 13.9	12.8, 13.0 } mean 12.9	7.9, 7.7, 7.9 } mean 7.9	6.0	1.5

large number of tests were made using lead nitrate crystals with γ-ray sources varying from 200 to 14 millicuries of radium emanation, the source and crystals being placed at different distances from the chamber A. The sensibility of the electroscope was also varied over a wide range.

Table I. gives a summary of the results obtained for six separate experiments with lead nitrate.

The percentage of total beam absorbed was obtained by dividing the total change in absorption from crystalline to non-crystalline state by the leak due to the entire cone of rays measured by connecting chamber B alone to the electroscope. For the above experiments in which a layer of lead nitrate crystals 3.4 cm. thick was used, with the 14 mg. standard as source of rays, this reading was 415 divisions per min.

TABLE II

	Number of Experiments	Weight in Grams.	Thickness of Layer in Cm.	Percentage of Total Beam Absorbed
Lead nitrate.........	17	250–70.5	3.4–1.2	2.3–.4
Lead acetate.........	8	196–29.2	3.5–.6	4.8–1.0
Potassium sulphate...	4	106	2.5	1.6–1.0
Hydrogen potassium sulphate..............	2	89	2.5	.6–.4
Potass. dichromate...	2	106	2.5	.34–.26
Mercuric bromide.....	1	124	2.5	1.0
Mercury nitrate.......	1	163	2.5	1.3

A detailed study of the effect was made using γ-ray sources varying from 200 to 14 millicuries of radium emanation, the source and crystals being placed at different distances from the chamber A. The sensibility of the electroscope was also varied over a wide range.

Table II. gives a summary of results obtained for a number of crystalline materials.

Since the size of the crystals differed greatly and other conditions of experiment were not the same in all cases, it is not possible to attempt any quantitative comparison of these results. They are inserted as an indication of the order of the effects observed.

EXPERIMENTS WITH CRYSTALLINE MERCURY

A more direct method would be to note the relative γ-ray absorption for some substance which could easily be obtained in crystalline and non-crystalline states. Water and mercury satisfy these conditions. Owing to the large density of the latter, it should produce a good deal of γ-ray scattering, and since it melts rapidly the sensibility of the electroscope would not alter appreciably during an experiment. The radiation entering the balance chamber was adjusted so as to give a very slow rate of leak of the electroscope for a given weight of mercury. The mercury was then removed and solidified in a Dewar vessel by the use of carbon-dioxide snow. The rates of leak with the solid mercury were then measured and observations taken as melting proceeded. More than 40 separate tests were made under widely varying experimental conditions, but while the data in general showed a small decrease in absorption for the fluid state, it was in most cases little more than the experimental error. The crystals obtained in every case were very minute.

SOLUTION EXPERIMENTS

A number of attempts were made to note a change in absorption for lead nitrate entering into solution. Other soluble crystalline substances were also tried including salt, sugar, etc. A large crystallizing dish containing 600

c.c. was used nearly filled with water and a uniform layer of medium-sized crystals placed on an iron gauze shelf midway between the bottom and the surface of the water. Any change of absorption was noted as the crystals went into solution. Slight changes took place as the material dissolved and went to the bottom, yet after a thorough stirring when solution was complete the readings of the electroscope returned to almost the initial value. A small decrease in absorption was noted, however, in the majority of the experiments.

It is hoped to repeat these experiments for mercury and solutions, using more refined apparatus and methods, and to study the effect of crystalline structure on reflection by an examination of changes in absorption for substances of high molecular weight which crystallize in two forms such as lead nitrate, mercury perchloride and mercury iodide.

In conclusion I wish to express my indebtedness to Professor Sir Ernest Rutherford for suggesting this general field of research; also to Dr. Ernest Marsden for many helpful ideas.

P. B. PERKINS

BROWN UNIVERSITY

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 561st meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, December 2, 1916, called to order by President Hay at 8 P.M., with 50 persons in attendance.

The following program was rendered:

The Discovery of an Interesting New Tardigrade: W. P. HAY.

Professor Hay gave a brief description of a tardigrade belonging to the genus *Batillipes* discovered by him some years ago at Beaufort, N. C. It is closely related to *B. mirus* Richters but differs from that species in a number of important characters.

The structure and relationship of the tardigrades was discussed and the conclusion was reached that *Batillipes*, in spite of its evident specialization along certain lines, is probably the most primitive genus of the group.

From *Batillipes* through *Halechiniscus* to *Oreella* and *Echiniscus* was suggested as one line of development, while from *Echiniscoides* through *Milnesium* to *Macrobiotus* and *Diphascon* appears to be another. The genus *Tetrakentron* with its single species *T. synaptæ* shows a high degree of specialization due to parasitism and *Microlyda* is probably the larval form of *Halechiniscus*.

Attention was called to the habitat of the bear animalcules belonging to these genera. Five of them, *Batillipes, Halechiniscus, Microlyda, Tetrakentron* and *Echiniscoides* are marine. *Echiniscus* and *Oreella* are strictly terrestrial. *Macrobiotus* is mostly terrestrial or lacustrine but is represented in salt water by at least two species. *Diphascon* is terrestrial and lacustrine.

The fact that the majority of the genera are marine and that this list includes all the more primitive genera points strongly to a marine origin for the group. It also supports the idea advanced by Professor Richters in 190[illegible] that the tardigrades are probably most closely related to the chætopod worms and should be removed from the class Arachnida in, or near, which the group is usually placed in our zoological text-books.

Professor Hay's communication was illustrated by charts and diagrams.

Exhibition of Venezuelan Plants and Fruits: J. N. ROSE.

Dr. Rose had on exhibition a large table full of fruits, fruit products and various articles made of parts of Venezuelan plants. He explained their usage and described the plants from which they were obtained. The specimens were obtained for the most part in the vicinity of La Guaira and Caracas. Dr. Rose's communication was discussed by Messrs. H. Pittier, M. W. Lyon, Jr., and others.

Poisonous Snakes: M. W. LYON, JR.

Dr. Lyon gave an account of the various specific substances that have been found in snake venoms, and outlined their modes of action on the various tissues of bitten animals. He spoke of the various antiserums that have been prepared against these venoms, and their therapeutic uses. He also called attention to the non-specific treatment of snake-bites in the light of modern statistics and experiments. He then gave a brief outline of the classification of venomous snakes, their geographic distribution, of the development and structure of the poison gland and fang. His communication was illustrated by lantern slide views of skulls, glands and fangs of poisonous snakes, of types of poisonous snakes and of some of the histological changes caused by snake venom. This communication was discussed by Messrs. A. A. Doolittle, H. Pittier, H. M. Smith, H. E. Ames and T. E. Wilcox.

M. W. LYON, JR.,
Recording Secretary

SCIENCE

FRIDAY, FEBRUARY 9, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PHILOSOPHY OF GEOLOGY AND THE ORDER OF THE STATE[1]

ONCE each year we come together to renew our strength, like Antæus, by touching the earth.

I am conscious of taking some degree of liberty in departing from the usual form of this established function—the annual address. It would gratify me and might in some measure have diverted or persuaded you, if this occasion were given to the illumination of some specific technical theme. But the spirit of the hour seems to impel me rather to read from out my experience and observation, or at least to portray, as I see it, some part of the obligation of the state to our science and the responsibility of this science to the state.

The occasion is perhaps opportune, not so much in this place of meeting which happens to be the seat of government of but one of the many states here represented, and in the presence of members from two great federated governments; but essentially because, for the sake of all parties of interest, we must recognize more clearly the civic element in geological science and insist more pertinaciously on the immediate as well as the ultimate dependence of a state, if organized to endure, upon the demonstrated laws of this science.

I wish I might extend to my colleagues among the official geologists of many states an assurance that this address is to be devoted to some added demonstration of the obligation of the state to exploit to the utmost its geological resources, for the sake

[1] President's address before the Geological Society of America, Albany, December 28, 1916.

of the commercial interests of its community, but such public arguments are now superfluous. It is a primary impulse and an almost elemental instinct in the state to develop the commercial assets of its rocks. The appeal is so direct, so simple, so imperative that no state can afford to ignore a well-directed official effort to increase thus the general well-being and comfort of the commonwealth. The broad proposition is not debatable; the proposition in detail has always been debatable and debated. Too often and too much in representative public opinion is the existence of the official geological organization justified by certain perfectly obvious considerations which subtend a large angle in the public consciousness. Gold and silver, iron and coal, petroleum and natural gas, and terms like these are made too often to set forth a reasonable vindication of official geology. But you and I may well insist that such factors as these reckoned in terms of the wealth of the state are not the justification of official geological research. We may as well draw back the veil—private enterprise will pretty effectively take care of such things as these without much help from us. Against such factors which we may term the obvious sources of wealth must be weighed the more recondite products which have seldom entered into the estimate of the lawmaking body or the public knowledge.

It is in these that many of our states are richest, not in those obvious factors. In a state like this, which I cite not for comparison, but for illustration, the unexploited iron ore would seem to be well over a billion tons, while the actual value of the annual product of iron is not more than one tenth that of the annual output from thirty or more different mineral products. And we can not even begin to estimate for our state the vast reserves in products undeveloped or conceive the now unknown applications to industry and the arts which our commonest geological compounds are competent to supply in response to the demands of the state.

I can see in such a state or in a union of states and governments such as ours, the demand for every human need, to-day actual and to-morrow possible, which is in any way dependent on the rocks of the earth, fully met here without reliance on any outside source. And it is of eminent importance that the state take counsel with itself to magnify such independence, at the sacrifice of its commercial ease, for dependence in commerce means no less than does dependence in the scheme of nature, that is, degeneration of stagnation.

I counsel, therefore, you who are official servants of the state, to urge, within your power, upon the state this primary obligation; to take from no other what it can itself as well produce from its own stores. Insist, as the right is in you, that the state shall take account of the knowledge you possess for the full but conservative development of its own resources, and neglect no occasion to enforce the claims of the man who knows best, to precedence in these councils of the states.

I would not seem to profane my high office by stating in this presence the elemental conceptions of the science, but it is most imperative that I here, and you elsewhere, shall be lucid, exact and comprehensive in setting forth its claims, namely and briefly: that there is no substantial conception of property apart from the products of the rocks, the soils, the mines, the water, the air—and these in all their functions are geological factors; that there is no correct understanding of the meaning of human life, individually or in its complex community relations, if we stand with our back to the great panorama of events

which have builded the earth and the trains of life which have moved over it from the dawn of its history. It is most essential that every state should above all things comprehend these facts.

The current of my thoughts is toward the well-established principles of geology which have constituted the state; not the state as a geographical section of the earth, and not just now those principles which have laid its material foundations, builded its rocks, formed its veins and beds of ore, made its soil, established the sources of wealth as expressed in terms of human market; but unavoidably I turn to those principles which illumine the trail of humanity and have given it direction. My time has been long enough to ripen some of the green fruit of experience and enforce some deep-seated lessons. In the light of this experience and these associations there is no escape from the earnest conviction that the things of supremest value to mankind, the refined essences of the earth, lie in its records of the life which has gone before us. As the emergence of what we call the living, quoting Professor Chamberlin, is the transcendent event in the history of the earth, there is certainly no other fact in the presence of humanity so vital as that and the vast procession of the ages with the key it holds to our present state and future hopes. Need I say to this audience what I would wish to say to a wider: We are passing, we have stopped only to see the march of life and play our small part in the tremendous and endless pageant, happy indeed if, endowed with powers of divination, the rays of truth have dawned upon us from out of the past, to light the imagination on toward better things.

To what extent, then, are we fortified by the evidence of the past career of life in reading its oracle for our present guidance? This inquiry sets plainly before us, first, the paramount question as to the oft-alleged and too often magnified imperfections of the record of life upon the earth.

In many, probably in most, expositions of the science of geology and paleontology, prepared for the use of students and general readers, the so-called imperfections in the record of past life are brought out with a vivid intensity. These expositions are, I think, in large part due to a more or less unconsciously apologetic attitude on the part of the authors, as though they were in some way, being apostles of the science, likely to be held to account for any overstatement of its claims; and these attorneys in bankruptcy are not inaptly, to my mind, comparable to buyers of ancient but damaged rugs, torn, raveled, worn bare of their patterns: ostentatiously declaring their defects while overlooking the beauty, the symbolism, the perfection of the design seen clear through all the ravages made by the wear of time.

I find myself out of sympathy with such deprecating portraitures. Neither my experience nor my philosophy finds support for pessimistic conceptions of the ultimate hope of completing our tapestries from the patterns we know and the threads we are yet to pick up. For a few years, as we reckon human history, we have scratched with our hammers some surface exposures of the tablets of the law in parts of the earth most easily accessible to us, and the occasional explorer into remoter parts has gathered the life records in haphazard way, here a few pounds' weight, there a few tons'. Not one fiftieth part of the exposed rocks of the earth has yet been closely scrutinized for these life records, and of the unexposed but known strata, practically none at all in the great total. This State of New York covers 47,000 square miles, two thirds of which are underlaid by life records of the earth. This fossiliferous area is one eight-

een-hundredth part of the land area of this globe, about one eleven-hundredth part of the exposed fossiliferous rocks. In this state the work of assembling the evidences of the life record has proceeded continuously in organized attack for eighty years. An eminent French geologist has intimated that there are few places of equal area in the world where the life record is so completely assembled—and yet every year brings new and necessary additions to our quiver. What shall we say of the other 1,099 equal areas of fossiliferous rocks on the earth? Many of them have indeed been studied with precision, but there remains and must remain for long years yet an overwhelming balance of the unknown. In the abundance and perfection of the life that is preserved in these rocks only the living seas themselves are comparable. I have estimated the number of individuals of a few of the species occurring in one insulated mass of marine Devonian strata known as the Percé rock, a section which above the waterline represents a sea deposit 300 feet thick, 1,300 feet long and about 250 feet wide; and the figures for these few species run into the hundreds of millions of individuals —yet the rock is not richly fossiliferous, in the customary use of that expression.

It seems to be my experience, too, that the most closely studied formations have already yielded up a large percentage of their actual fauna. For some well-studied formations in limited areas the known fauna is, approximately speaking, a true and fairly full expression of the actual fauna. I can not of course pursue this matter here into its further details with its brilliant vistas already before us of learning the inchoate life of the primitive soils and first impounded waters, but I think I shall venture to enter the lists on call, to contend that for plant and animal life alike the records of the rocks, where unaltered, are unimpeachable for adequate suggestiveness of the designs which the threads of life have woven. And when the imputation is too often made of imperfection through loss of anatomical detail, or the destruction of essential structures, compare by way of simple illustration compressed into the emergencies of this occasion the growth of knowledge of fossil anatomy within the fragment of the lifetime of one man. Fifty years ago all that was known of the ventral organization of the trilobite was a mere suggestion embedded in a nest of speculations; of its ontogeny a few discrete facts. So far has knowledge advanced that to-day we seem to know these animals in all their essential details and development; and if aught is left to become known of internal anatomy or ecology, the lessons of the past are the promise of the future. What was known of the Eurypterida fifty years ago was little but their outline and their grosser form. To-day their ontogeny is understood almost from birth onward, their anatomy almost to ultimate details, their habits at least as well as those of vast numbers of living animals, their phylogeny as well as or better than the phylogeny of any living race subjected to this speculative treatment. Supplement these illustrations, which are nearest to me, with the scores of others known to you and with the tremendous strides made in this same period of time among the extinct vertebrates, and within the realm of lost floras where sheaves of knowledge have piled higher with every year.

These are the theses I should wish to nail on the doors of our temple:

Nature makes for the individual. This truth is registered on the tablets of the earth; it lies also in human observation and in human experience. Its recognition is of paramount importance; its acceptance sweeps away cobwebs of vagrant hypoth-

eses which befog the pages of writers on political and social economics.

In the progressive line of development which in the present terminates in us, the procedure of nature has been one of only limited concern for the family and of tried out and abandoned experiment for social partnerships and the division of labor. To perfect the individual inconceivable safeguards have been thrown about him. The individual is creation's unit in terms of which all progress in life is to be reckoned. With unsparing hand she makes and wastes these units, both for her greater purposes and those which we may call her lesser ones. Units of purpose are wiped away to make place for units of other purpose. Yet the unit type remains; remains with its full seeding of possibilities, armored for its fight with double portions of food supply, of sense organs, of locomotive means, with an inexpressible superfluity of reproductive supply. Whether a given unit survive till its work be done or perish in the doing, it is the individual type that is at stake, it is against this individual type that all the powers outside it are imposing their obstacles.

This the geologist knows: There has been no cooperation in the historic development of the life in which we are directly concerned. We may not yet know the trend of many life lines for far in their history, but wherever such lines are best known, within the limitations of large natural divisions, those that run through from limit to limit and point the way both backward and ahead, and those other lines collateral to ours which have ended and determined fruitlessly—these all can be conceived in no other way than variant expressions of the individual. And in the history of human life is it aught else than the individual that has stood for the progress of mankind? Was it the barons at Runnymede, was it some bill of rights, some declaration of independence, some joint action of human agencies that have been the crowns of our achievements? Or was it the Aristotle, the Plato, the Socrates, the Christ, a solitary Shakespeare, an incomparable Franklin, a rebellious Darwin, or the historic twenty individuals, who have stood for the progress of the race?

I say this only for the purpose of saying *per contra*, that the history of the excellent life (and by that I mean the line of life that is best perfecting its psychology), has shown the futility of attempts at progress through any other agency than the independent individual. This is so important a conclusion to every state taking cognizance of its dependence on natural laws that it is highly essential to consider nature's own alternatives to such individualistic effort, her own experiments in trying out other modes of ascending heavenward. For "individual liberty," said President Butler speaking before the constitutional convention of this state, "is the cornerstone of the free state." That is the decree which is written in burning letters on every milepost of the course of life. "The perfection of the individual is the perfection of the race" says Professor Hoffman, "but," he adds, writing on the organization of the state, "the individual can have no rights or duties that conflict with the good of the whole"—a supplement for which it is exceedingly doubtful that any substantiation can be found in nature.

(*a*) It has been my environmental control to study and, I hope, to learn some of the lessons of life from their simplest and most legible expressions—a result that has come from living and laboring in a state built from the early waters with their undifferentiated expressions of life. The panorama of successive early worlds of life glows with the simple expressions of law

which become more involved, supplemented and beclouded as the passing of the ages complicates the process of higher evolution, and produces expressions which, in terms of existing life alone, would be difficultly intelligible. The study of the meaning of existing life without the light of its vast history leads nowhere.

It is safe to say, I think, that living beings at the start, animated nature whatever its composition, had an equal chance for progress and improvement. How soon that chance became forfeit we can not say, but it is obvious that life was not long begun and its greater stocks established when their courses throughout existence were set and determined. Nothing is more obvious in chronology than nature's deliberate failures, nothing more clear in paleontology than her set purposes.

The vast subkingdom of the Mollusca started well with bodily independence, fully equipped with locomotive powers, an excellent innervation, but they sold their birthright for ease and content. They soon became dependent upon the movements of the waters and waited for the waves to bring them food. Compact in their protection and adaptation, these types of life have come crowding down through the ages in inexpressible variety. They and their allied phyla in the great subkingdom to which they belong have, it would seem, struggled now and again to regain their primitive independence and maintain it, but the early condemnation of the law has overawed them and out of them all has come, and can come nothing better. They had their chance. That chance was missed; for untold millions of years they have failed to improve. They still cumber the earth and teach the lesson of an incurable heritage. You who are students of ancient life know how great is the multitude of lessons like this.

None of the observations of the competent have afforded any evidence that the lines of development through such groups of lowly animals have led to anything of promise or of excellence. The ages have rolled away and left them still with us, progressed, arrested or degenerate within their own narrow limitations, as the case may be. There is no evidence to indicate that these great groups from which nothing can be expected were deprived of their equality of opportunity as contrasted with the other great subkingdoms of the annelids and the articulates from one or the other of which, or from one and the other in succession, our own line has been derived.

The lesson then is this, that dependent conditions of life, however we may see them, throughout untamed nature or in our own communities, are not primitive, are not in the essence of things, but they are set back so far in the history of life that they are now or seem to be unavoidable and unconquerable.

These evidences I have discussed before this society on previous occasions. The field of observation and of inference as well, is greatly to be enlarged and well justifies the appeals that have been made on its behalf, but so much at least is indicated: that here and in analogous cases parasitic existence in whatever group in nature, and with whatever expression in the natural assemblage or the community group, involves the essential abandonment of normal direct upright living and the benefactors thereby are types of life which nature has cast out and aside as hopeless.

It is probably yet to be determined, at least there is no record I can find, that even in the passing of the ages nature has ever set up again upon its feet an organism or group of organisms once fallen into this dejected mode of life.

It is well the state should recognize this

harsh truth which is a law. With a police power guided by intelligence and sympathy, some of the harshness in this inevitable human condition may be ameliorated, but the paleontologist looking at the record of life on the earth says to this state: Be intelligently guided in the treatment of hereditary community parasites, defectives, congenital or confirmed misdemeanants, whatever the form of degeneration may be, by recognition of the presumption that in so far as they can not be physiologically corrected, they are abandoned types in which there lies little hope of repair. I can state this conclusion only thus succinctly without here attempting to present or argue its many ramifications.

(*b*) Soon after the great outburst of articulate life in the Cambrian, wherein, so far as our present knowledge permits, we find the lines along which have come the complicated expressions of to-day; somewhere in there, we may not say securely now, branched out the great phylum which led into the world of insects. We are wont to say that the first whirr of insect wings was made by the dragon flies and great cockroaches of the Devonian forests—an admission which of course implies that long earlier ages saw the differentiation of this type of life. At all events the six-legged type of articulates adapted to life in the water and air, full of vivacity and agility, with full independence, equipped with all potentialities that come from abundant innervation—this type, this six-legged articulate expression of existence, the insecta, started reasonably early on its career. It is my desire to note only in passing that, however close and direct may be the derivation of the vertebrate type from the primitive articulate stock, we have no inheritance from and hence only a collateral interest in this six-legged type of articulate life. Yet the outcome of development along this line has led to most extraordinary displays of morphological and psychic differentiation. A distinguished naturalist has said that the brain of an ant is the most marvelous speck of matter in existence. I hardly need, before this audience, to recall the exquisite and minute specialization in morphology, physiological function, performance and, I should say, conscious or at least psychic behavior among the most advanced attainments of development in the six-legged articulates, the social insects. The ant colony is the ideal of differentiation of function. Its members are by birth and inheritance, food and training, destined to certain specific duties in the colony. Armies are marshalled, wars are waged, the wounded nursed, the captives are trained for their duties, gardens are planted and crops are harvested; the stock is fed and food is stored, and a score of marvelous concerted doings which amaze us by the perfection of their totality, which is—the welfare of the community. Here the individual is actually constructed nervously and physically, anatomically and physiologically, for the niche in the community which he is destined to fill. No human community where cooperative efficiency has submerged the individual and has been the objective and the attainment, no such human community has ever yet reached such an ideal of joint effectiveness as has a colony of ants. The ants are nature's great triumph, her highest performance in communistic effort and in cooperative achievement. And what has come or can come of development along this line?

Let us look back a little into the antecedents of the ants. Says Professor Wheeler:

So many genera and species of these insects appear full fledged in the early Tertiary we are compelled to believe that they must have existed in

the Trias or even in the Lias, but belonged to so few genera and species, or lived in such small communities that they left no remains.

This distinguished student cites 276 Tertiary species as indicative of their sudden outburst, or perhaps it would be safer to say the development of better modes for their preservation, and he has further stated that there is no reliable observation to prove that polymorphism was existent among the earliest ants of this long period. This differentiation does, however, show itself in the fossil ants of the Quaternary.

This paramount attainment of intellectual activity in the line of insect development, in the line of the six-legged type, would seem thus to have been accomplished largely through the same period of time when the human line was perfecting its mentality. The psychology of the two ultimate results is separated by processes and directions of development as wide apart as the poles. Neither is to be expressed, perhaps, in terms of the other. The results too are wide asunder—one a deadly communism, a moribund partition of labor, a lethal socialism; the other an active, progressive and fertile individualism. For the former the student of nature's history sees no outcome. These too are nature's experiments. The six-legged type with all its purposes, in its highest expression lies prostrate on the ground at our feet, it and its achievements have risen to nothing higher than an ant hill, its communistic relations and subservience are entirely apart from the true genius of humanity. Socialism and communism have been tried out and found wanting, and nature holds conspicuously before the eye of the state the warning that they have nothing either for the growth of the spirit or the progress of the intellect.

(*c*) I regard as peculiarly a doctrine of paleontology, one whose demonstration or confutation would be hopeless in the hands of the biologist, that of palingenesis, or recapitulation, or in other words the broad and familiar statement of the fact that each individual carries in himself and his development history, the history of the race to which he belongs, however accelerated or however retarded it may be. I am trenching familiar ground, but it is because I would remind this audience that not the mere existence, but the panorama of life, is essential to this conception and that the law remains only an assumption of probability as long as its manifestations are pursued only among creatures of high specialization. In our bodies politic the more complicated our existence becomes the more like a tangled web of ordinances become our statutes. Forty-five thousand new statutes it is said have been enacted in the last five years in these states for some of us to trip and fall over, and just as it is difficult to pick our way through this tangle of expediential legislation, so it is likewise difficult to read in highly specialized organisms the leading of this great governing principle of biogenesis. If we do trip and fall among the entanglements of the statutes, the difficult mechanism of our present community life, let us remember that also back even of the bewildering, confusing, interlocking webs of the physiological mechanism of evolution lies, outspoken and luminant, the simpler expressions of the basic law on which rests the whole superstructure of evolution whether of the individual or of the state.

(*d*) It is well for us, well for the state, that we read aright the teaching of the greater past upon the doctrine of majority control, for whatever enduring virtue it has takes its roots in these past procedures of life when laying the foundations of its phyla. Over and over again the dominant race has started on its career as an insig-

nificant minority struggling for its existence against an overburden of mechanical and vital obstacles, armed only with specific virtues which have little by little fought their way into the foreground, and by so doing consummated their upward purpose. If I refer to the geological history of the phylum to which we belong, the Mammalia, it may stand for the oft-repeated procedure which has in various forms come under the notice of every paleontologist. The Prototheria, or the first of all mammals, appeared upon the scene in the Jurassic, diminutive, mouselike creatures even yet retaining from reptilian ancestors the function of ovulation, possibly having already developed a marsupial pouch for their nurslings, insectivorous in dentition, creeping inconspicuously through sheltered places of the forests or among the crevices of the earth, their minute but agile brains, by which they were steering their course, tremendously exceeding in proportion the brains of the giant reptiles whose variant forms constituted the majority and made them masters of earth and air and sea—whose gigantic physique and fleshly lusts had outstripped the early promise of their cephalic ganglia and left them hopelessly decephalized. Insignificant in size and number, but equipped with the vigor of phyletic youth, agile adaptability, locomotive independence left unimpaired through excessive food supply, with such equipment, good balance between cephalic and motor nerve centers, these inconspicuous and feeble folk started on their career of triumph over an overwhelming majority. Time passed and the deed was done. The agile-witted founders of the race had spread abroad through the earth. They grew vast in number and variety, adapted to all media of earth and air and sea. To them at last came the temptations of the flesh pots; they grew great in bulk, slow in body, weaker in locomotion and feebler in proportion. They too had met their impasse and there was nothing beyond. The majority had arrived, but the majority had fed itself fat on the spoils of the conquest and was moribund. Once more out of this majority arose the protest of the minority and again the keener witted, better cephalized, unimpaired, but obscure and diminutive minority, strong always at the head, emerged from the welter of self-indulgence to save the race. Robbed of luxuriant food supply by a mantle of ice, its vitality quickened and stimulated by the invigorating cold, imperiously compelled by a world chill which hung upon the earth unknown years to purge itself of indirection and seek the straightest way to physical salvation through the practise of simple virtues; from out of such conditions came the human stock.

If we do not recognize fully the fact that a majority control in our governments is purely a matter of expediency in the handling of civic affairs, let us remind ourselves of it on this occasion. We need only the reminder, for however often the man in the ward and the voter at the polls conceives that a majority is the paramount issue at stake, it is too often forgotten that the majority is purely numerical while wisdom and truth may rest with the minority. Amidst the inevitable expediencies of government this is its salvation—that the minority, if clear and strong at the head, like an antecedent river, will cut down mountains of opposition.

Said Lord Acton:

> The triumphs of liberty have been due to minorities. The rule of the tyrant is tyranny whether he have one head or many. The principle of absolute majority rule is as profoundly immoral and as profoundly undemocratic as is the principle of the divine right of kings. Majority rule is a practical device for the working of free institutions and not

a principle without limits or bounds upon which free institutions may be based.

This is the teaching of our science; the ephemeral worth of majority control is always obvious; the voice of the people is not the voice of God.

(*e*) We have come to a point in our researches where observation and inference teach us that life originated in unicellular microbic forms under conditions which have been indirectly indicated by the Chamberlins, father and son, as governed by and intimately associated with a conjunction of soil and moisture, with obstructed air, and probably without direct exposure to the actinic action of the sunlight. There has already been interesting and substantial confirmation of the presence of actual bacteria in the most ancient rocks of continental origin antedating the Cambrian, and many well-demonstrated expressions. The discovery of fossil bacteria is to be accredited to several students, Van Ingen among others, but their existence in this age preceding the primordial outburst of life, in times when by every line of sequential reasoning they should exist, this important determination is among the brilliant results of Walcott's researches.

So now every legitimate evidence of fact and deduction points to the origin of microbic unicellular life in the moist, subaerated soil away from the direct sun; and the soils of to-day are alive—a mighty host—with such microbic creations existing under paranaerobic conditions. This army, we are coming to understand, is endowed with specialized functions; and if this statement is, and is to remain, approximately correct, then the acquisition of such special functions speaks of a long past with its gradual and cumulative inheritance. It still remains to be demonstrated that the cycle of life is renewing itself from day to day by the continued transmutation of the inorganic to the organic, however such a possibility may lie in the lap of logic. But it is well for us to realize that this microbic life which in the passage of time has become adapted to such special functions that we recognize among them germs of disease as well as of benignancy, has the historic impress of hostility to the direct rays of the sun. Microbic disease is disease only from the human standpoint, from the point of view of the host of the disease-causing parasite. For the germ—the microbic parasite itself—it is normal living. I think we may well urge upon the attention of pathogenists the importance of estimating the historic impress which is, in all disease-making bacteria, the natural primitive and inherited hostility to the sunlight. In the adjustments and readjustments of these parasites to special hosts and specific toxic processes some may have overcome in a measure this natural antagonism, but for the most their work is in the dark. The marvelous results which have been attained in the treatment of tetanus during the present war, by simple and constant exposure to the sunlight, encourages us to believe that in similar pathology a like treatment would be historically and logically correct.

Fifty years ago, when President Andrew D. White published his "Warfare of Science and Religion," he said:

A truth written upon the human heart to-day in its full play of emotions or passions can not be at any real variance with the truth written upon a fossil whose poor life ebbed forth millions of years ago.

These fifty years since have enabled us to say with equal security that the record written on the fossil is the candle by which we must read the fate of the community, the passions and emotions of the human heart.

We have been shocked into a consciousness that not all the virtues abide in us.

You may recall the ancient days of Rome when the people annually gathered to pay an offering of oil and wine, of milk and violets to the spirits of their ancestors, from the study of whose examples they gained for themselves and inculcated in others a respect for the virtuous past. So we say our *aves* to the great past out of which we and all our guiding principles in individual life, in the community, in the state, have come.

Our broader vision which must be the bloom of our intense specialization is like the dream of the patriarch who, resting his head on a pillow of stone, saw a ladder reaching from this earth to heaven and beheld the angels of God ascending and descending on it.

JOHN M. CLARKE

STATE MUSEUM,
ALBANY, N. Y.

THE COMMITTEE OF ONE HUNDRED ON SCIENTIFIC RESEARCH OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORT OF THE SUBCOMMITTEE ON ASTRONOMY

THE science of astronomy differs in a marked manner from many other departments of human knowledge. Owing to the large sums of money which have been given to it, extensive organizations have been effected, thus enabling astronomers to undertake the great routine investigations which at present are regarded as the most important objects of astronomical research. No one will doubt that in this, as in every other science, the advance depends largely on individual genius and initiative. The invention of new methods has, however, now been so far accomplished that many astronomers are able to devote their time to applying these methods to large numbers of individual stars. Investigations which require years of continuous effort, and an expenditure of many thousands of dollars may thus be undertaken and successfully completed. The application of the methods of scientific management has effected the same saving as in industrial processes. An excellent example of this is the determination of the accurate positions of one hundred thousand northern stars. This work, begun half a century ago, was divided among a dozen observatories, and was probably the most important astronomical research undertaken up to that time. One zone occupied an observer and corps of assistants for twenty years. The salaries alone exceeded one hundred thousand dollars. By the aid of photography this work is now being repeated with double the accuracy, and at less than a tenth of the cost. In another investigation, a saving of one minute in the reduction of an observation will reduce the time of its preparation by two years of the work of one assistant.

The greatest need of astronomy appears to be a large fund whose income could be used in the following ways:

1. Reestablishing the friendly international relations of astronomers of three years ago by assisting large astronomical projects directly or indirectly. Such projects can often be carried out far better and more economically by dividing the work between two or more observatories. The Cape Photographic Durchmusterung is a striking example of the excellent results of such cooperation.

2. Furnishing assistants to astronomers who would thus be relieved of laborious routine observations and computations. An excellent illustration of this was the article in SCIENCE, Vol. 41, 82, giving the replies of twelve leading astronomers regarding their greatest need. In almost every case it was one or more assistants.

3. Aiding observatories south of the equator in such a way as to render our knowledge of the southern stars more nearly equal to that of the northern stars. At present, many times as many observations are made of northern, as of southern, stars.

4. Providing means whereby preliminary investigations, sufficient to decide upon the best and most efficient methods of carrying on large projects, can in all cases be undertaken before these projects themselves are entered upon.

5. Establishing bureaus, generally at existing institutions, at which certain lines of investigation could be carried on for any astronomers needing them. For example, a computing bureau which would prepare the tables needed for any special or general purpose, as a bureau for computing orbits of newly discovered asteroids, or comets, a bureau for measuring photographs, thus determining precise positions, radial velocities from spectra, etc. Such work can be carried on far more efficiently by an astronomer in his own surroundings than if he is transported to a new establishment.

6. Making arrangements by which astronomers, overburdened by teaching, would be enabled to devote a specified portion of their time to research.

7. Assisting students taking postgraduate courses in astronomy, so that they could continue such work.

8. Supplying small telescopes, or other appliances, to those qualified to use them.

9. In general, aiding the advance of astronomy in any way that might prove efficient.

E. C. Pickering,
Chairman
Ernest W. Brown,
William W. Campbell,
Edwin B. Frost,
Henry N. Russell,
Frank Schlesinger

REPORT OF THE SUBCOMMITTEE ON CHEMISTRY

The following recommendations concerning the organization of efforts to advance the cause of research in chemistry are made on behalf of the committee in an informal way. The members of the committee exchanged opinions by correspondence, but no formal report was discussed by them.

1. To avoid duplication of work, to secure unity and strength of effort and to save the time of research chemists overwhelmed with committee work on this subject, the fusion of the research committee of the Committee of One Hundred and of the National Research Council, as recommended by the Committtee on Fusion, is strongly endorsed.

2. A survey is recommended of all the investigators in chemistry, including those connected with universities, colleges, the government, state or municipal services, endowed research institutions and research laboratories of industrial establishments—with special emphasis on the field of work for which each man might be available.

3. The organization of efficient but simple means is recommended for bringing to the attention of research men in universities and colleges, who indicate an interest in technical research, those problems of manufacturers in the various states and centers of the country, which could be handled in the laboratories in question.

4. The consideration of the issue of a warning to universities and colleges is recommended in regard to:

(*a*) The imminent danger of allowing the university laboratories in which research men for the whole country are trained, to be too much weakened by the loss of staff of pronounced research ability to the technical research laboratories.

(*b*) The importance of protecting research teachers against the encroachments of administrative duties of every kind.

(*c*) The importance of giving younger members of the staff of proved research ability every opportunity in the way of time, facilities and assistants for the development of their full powers.

(*d*) The necessity of definitely protecting research in pure science where provisions are being made for closer connections with technical problems.

5. The furthering of plans for cooperative research between departments and between institutions is recommended for consideration.

J. Stieglitz,
Chairman

REPORT OF THE SUBCOMMITTEE ON RESEARCH FUNDS

During the year which has elapsed since the last annual meeting of the American Association, the report then made has been revised and somewhat extended. In this revised form it has been printed in Science.

Reprints of it accompany this report. They can also be sent to members of the Committee of One Hundred who so desire.

It is intended presently to collect data regarding Astronomical Observatories and Marine Biological Laboratories which hitherto have been delayed by unavoidable circumstances.

It is desirable to secure authoritative information regarding the appropriations which are annually made by the federal government and many state legislatures for research in agricultural and engineering subjects, unless the committee should be relieved from doing this because of the similar work undertaken by the committee appointed by the National Academy of Sciences.

CHAS. R. CROSS,
Chairman

SCIENTIFIC NOTES AND NEWS

DR. JULIUS STIEGLITZ, professor of chemistry in the University of Chicago, has been elected president of the American Chemical Society. Dr. Stieglitz has also been elected president of the Society of Sigma Xi.

THE alumni of Columbia University will give a dinner on February 19 in recognition of the university's contributions to science and engineering. The guest of honor will be Professor M. I. Pupin, who completes his twenty-fifth year of service to the university.

THE gold medal of the Royal Astronomical Society has been awarded to Mr. W. S. Adams, of the Mount Wilson Solar Observatory, for his investigations in stellar spectroscopy.

THE Geological Society, London, has this year made the following awards: Wollaston medal, Professor A. F. A. Lacroix (Paris); Murchison medal, Dr. G. F. Matthew (Canada); Lyell medal, Dr. Wheelton Hind (Stoke-on-Trent); Bigsby medal, Mr. R. G. Carruthers (H.M. Geological Survey); Wollaston fund, Dr. P. G. H. Boswell (Imperial College of Science); Murchison fund, Dr. W. Mackie (Elgin); Lyell fund, Dr. A. H. Cox (King's College, London), and Mr. T. C. Nicholas (Trinity College, Cambridge); Barlow-Jameson fund, Mr. H. Dewey (H.M. Geological Survey).

AT the suggestion of the chairman of the National Research Council of the National Academy of Sciences the following Committee for the Encouragement of Research at the University of Chicago has been appointed: President Judson, Trustees Martin Ryerson, Julius Rosenwald and Harold Swift, Professors Coulter, Michelson, Millikan, T. C. Chamberlin, Stieglitz, E. H. Moore and Bensley, and, from the alumni of the university, Dr. F. B. Jewett, of the Western Electric Company, New York City, and Dr. R. F. Bacon, director of the Mellon Institute.

RAYMOND CECIL MOORE, Ph.D. (Chicago, '16), has been appointed head of the state geological survey of Kansas. Dr. Moore has been engaged in geological survey work in Missouri and Illinois and for the United States government, and is now connected with the University of Kansas.

AT the annual meeting of the trustees of the Rockefeller Foundation Dr. George E. Vincent, president of the University of Minnesota, was elected president of the foundation to succeed Mr. John D. Rockefeller, Jr., who was appointed chairman of the board of trustees. Messrs. Charles E. Hughes, Julius Rosenwald, of Chicago, and Dr. Wallace Buttrick, chairman of the General Education Board, were also elected trustees, and Mr. Edwin Rogers Embree, assistant secretary of Yale University, was elected secretary to succeed Mr. Jerome D. Greene.

GEORGE R. LA RUE, assistant professor of zoology at the University of Michigan, has been appointed director of the University of Michigan Biological Station at Douglas Lake, Michigan.

DR. WILLIAM S. STONE has been appointed assistant director of cancer research of the Memorial Hospital, New York City.

MAJOR JOHN A. AMYOT, Toronto, formerly director of the Ontario Board of Health laboratories and professor of hygiene and public medicine in the University of Toronto, has

been appointed sanitary adviser in England to the Canadian forces.

We learn from *Nature* that Mr. Udny Yule, one of the honorary secretaries of the Royal Statistical Society, has been appointed head of the Information and Statistical Bureau of the British Ministry of Food. With Mr. Yule will be associated Professor T. B. Wood, Drapers professor of agriculture in the University of Cambridge, and Professor W. H. Thompson, professor of physiology, Trinity College, Dublin.

Professor George C. Whipple, of Harvard University, has recently made to the New York state commissioner of health a report on the proposed plant at Staten Island for the disposal of the garbage of the city of New York.

Dr. R. Tait McKenzie, professor of physical education at the University of Pennsylvania, is now making a standard design for all medals given by the Intercollegiate Conference of Western Universities. This design will serve for the large medals given by the conference to the individual point winner in its outdoor meets.

At the last meeting of the American Phytopathological Society, from December 27 to 30, in New York City, the following officers were elected:

President, Mel. T. Cook, N. J. Agricultural Experiment Station.

Vice-president, Chas. Brooks, U. S. Bureau of Plant Industry.

Councilor, H. S. Jackson, Indiana Experiment Station.

At the annual meeting of the State Microscopical Society of Illinois held in the auditorium of the College Club, Chicago, on January 16, the following trustees were elected, Dr. Albert McCalla, Dr. Lester Curtis, David L. Zook, Francis T. Harmon and Jeremiah A. Hynes. The officers elected for the coming year were:

President, N. S. Amstutz.
First Vice-president, Dr. I. J. K. Golden.
Second Vice-president, Professor G. E. Marsh.
Treasurer, Frank I. Packard.
Curator, Henry F. Fuller.
Corresponding Secretary, Dr. V. A. Latham.
Recording Secretary, Charles A. Ruhl.

At the meeting of the Washington Academy of Sciences on February 1, in the auditorium of the New National Museum, the retiring president, Dr. L. O. Howard, delivered an address on "The Carriage of Disease by Insects."

At the 505th meeting of the Anthropological Society of Washington, Mr. William H. Babcock read a paper on "Certain Precolumbian Notices of the Inhabitants of Atlantic Islands." He referred to early Norse and Celtic legends, the story of Atlantis, and later tales recorded by Diodorus Siculus and Plutarch. The geography of the Arab writer, Edrisi, was considered at greater length, and the rest of the paper was taken up with accounts of the Canary Islanders given by him, and by later authors, such as Bontier and Leverrier, Azurara and Cadamosto.

Professor James W. Jobling, of Vanderbilt University, lectured before the New York Academy of Medicine on February 3 on "The Influence of Nonspecific Substances on Infections."

Dr. Robert M. Yerkes, of the department of psychology of Harvard University, and psychologist to the psychopathic hospital of Boston, lectured at the University of Minnesota, before the Minnesota chapter of Sigma Xi on January 26. The subject of his lecture was "Psychological Methods of Examination and Diagnosis."

Professor A. W. Goodspeed, of the University of Pennsylvania, has recently completed a course of three lectures on "Light, Visible and Invisible," at the Brooklyn Institute of Arts and Sciences.

On January 25 Dr. A. Hrdlička spoke on "Anthropology" before the Colonnade Club of the University of Virginia; and on January 26 he gave a lecture before the faculty and advanced students of the university, on "The Evolution of Man."

The Gifford lectures at Glasgow University are this year being given by Professor Samuel Alexander, of Manchester University, on "Space, Time and Deity."

IT is stated in *Nature* that Professor and Mrs. Herdman have recently established and endowed an institute at Port Erin, Isle of Man, for social and educational purposes, as a memorial to their son, Lieut. George A. Herdman, who was killed in action near Montaubon, in the battle of the Somme, on July 1, 1916. Lieutenant Herdman spent a great part of his boyhood at Port Erin, associating with the local fishermen and working at the Marine Laboratory.

DR. N. H. J. MILLER, who since 1887 has worked at the Rothamsted Station in England, died suddenly on January 12.

J. B. A. CHAUVEAU, member of the section of agriculture of the Paris Academy of Sciences, has died at the age of eighty-nine years.

THE Agassiz house, at the corner of Broadway and Quincy Street, Cambridge, has been damaged by fire to the amount of $15,000 to $20,000. It will be hardly worth while to rebuild from the structure that remains. Practically all the partitions from the roof down to the second story are destroyed. The house, which since 1910 has been the property of Harvard College, was insured for $10,000. After Louis Agassiz's death the house was used by Alexander Agassiz, and, together with the house occupied by Professor Hurlbut, was later bequeathed to Harvard College.

AT a meeting of the Board of Managers of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences at Cold Spring Harbor, N. Y., the completion of an endowment of $25,000 for the laboratory was announced. The principal donors are: Mr. W. J. Matheson, estate of Colonel Robert B. Woodward, Mr. Walter Jennings, Mr. A. A. Healy, Mr. August Heckscher, Mr. Cleveland H. Dodge, Mr. Louis C. Tiffany, Mr. Howard C. Smith, Mrs. E. H. Harriman, Colonel T. S. Williams, Mr. Henry F. Noyes, Miss Cornelia Prime, Mr. Albert Strauss and Mr. Donald Scott.

THE "Norsk hydroelektrisk Kvaelstof aktieselskab" has set aside 100,000 kr. to be transferred to the Nansen fund trustees, Christiania, Norway, for the promotion of chemical and physical research. In as much as the founder of this company, Sam. Eyede, celebrates his fiftieth birthday on the twenty-ninth of October the company desires that this fund be known as "The Sam. Eyede fund for the promotion of chemical and physical research."

MR. BENJAMIN W. ARNOLD has presented to the New York State Museum his large oological collection, which contains nestings of about 1,000 species of North American birds, and several hundred species from South America, the West Indies, the islands of the South Atlantic, New Zealand, and the countries of Europe. It also contains a large series of nests and other scientific material. Mr. Arnold has been a life-long student of birds, and in view of his gift and his continuing interest in the subject, has been appointed honorary curator of ornithology in the State Museum.

HARVARD UNIVERSITY has recently acquired the mineralogical collection of the late Elwood P. Hancock of Burlington, N. J. It contains more than 2,000 pieces, almost all of which are native to the state of New Jersey. Many of the finest specimens were obtained in the vicinity of the zinc mines at Franklin Furnace, N. J. During Mr. Hancock's researches, which covered every part of the state, he discovered a new mineral to which his name was subsequently attached by the Museum of Natural History in New York.

THE Philippine government has made available funds for the establishment of a permanent tobacco experiment station in the upper Cagayan Valley. The station is to be administered by the Bureau of Agriculture, with the Bureau of Internal Revenue and the College of Agriculture of the Philippines contributing advice and other assistance. D. B. Paguidigan and Alfonzo B. Cagurangan will be members of the staff.

THE finance committees of the senate and assembly of New York State have agreed on a plan for state institutions covering a period of ten years and involving the expenditure of $20,000,000. This money will be used to build new hospitals for the insane and institutions

for the feebleminded, as well as repairs for existing institutions.

We learn from the *Journal* of the American Medical Association that plans have been prepared for the new John P. Scripps Memorial Hospital for working men and women in San Diego. As a preliminary step, the San Diego Diagnostic Group Clinic for John P. Scripps Foundation is at once to be put into operation in the Scripps residence, which has been donated for that purpose. Mr. Scripps guarantees a sum up to $250,000 for the clinic and the erection, furnishing and equipment of the hospital. He also agrees for a term of years to meet, up to the sum of $30,000, any deficit in the amount required for the maintenance of the institution. Drs. Bernard J. O'Neill, Harry C. Loos, John E. Jennison, Vernon G. Clark and Harold A. Thompson comprise the executive committee of the institution.

The first lecture in the spring term of the course of popular science lectures maintained by the California Academy of Sciences in its new museum building in Golden Gate Park, San Francisco, was given Sunday afternoon, January 14, by Dr. R. G. Aitken, astronomer, of Lick Observatory. Dr. Aitken's subject, "A Total Eclipse of the Sun," proved one of very great interest. Other lectures are:

January 17. By Dr. F. M. McFarland, professor of histology, Stanford University, on "The Structure and Development of the Molluscan Shell."

January 21. By Dr. Frank W. Weymouth, assistant professor of physiology, Stanford University, on "The Edible Crabs and Fishing Methods on the Pacific Coast."

January 28. By Dr. James Perrin Smith, professor of paleontology, Stanford University, on "Alexander von Humboldt."

February 4. By Miss Alice Eastwood, curator of botany, California Academy of Sciences, on "Trees and Shrubs of the Grand Cañon."

The *Journal* of the Americal Medical Association states that the ninth quadrennial Scandinavian congress for internal medicine was to have been held in Finland this spring, but the war prevents. Arrangements have now been made for the meeting to be held at Copenhagen in August, 1917. The subjects appointed for discussion are "Importance of Dieting in Treatment of Insufficiency of the Heart and Kidneys," and "Neurasthenia in Relation to Psychopathic Conditions." V. Scheel, Bispebjaerg Hospital, Copenhagen, is the secretary. The twenty-third annual meeting of the German internists is planned to convene at Wiesbaden in the coming April. The main addresses announced are on "Nutrition in War," "The Constitution as a Cause of Disease," and "The Rarer Infectious Diseases encountered during the War." W. Weintraud, Rosselstrasse 20, Wiesbaden, is the secretary. The announcement of this meeting specifies that communications for it will not be accepted if their essential content has already been published.

The Board of Agriculture and the Development Commissioners of Great Britain have been considering the establishment of a research institute to investigate problems relating to agricultural machinery, and they consider that the institute could be most suitably established at Cambridge in association with the existing schools of engineering and agriculture. The Board of Agricultural Studies feel that the university should give a cordial welcome to the proposal. It is suggested that the principal officers of the institute should be (1) a director with experience of mechanism, and (2) an assistant director, who would be an agriculturist. For the former a stipend of £700 a year is suggested, and for the latter one which would range between £250 and £500. The building, probably at first of a temporary nature, could be erected adjoining the School of Agriculture, and land required for experimental work could be found on the two university farms. The establishment of the institute in Cambridge would not throw any burden on the university funds.

UNIVERSITY AND EDUCATIONAL NEWS

The Hon. William B. McKinley, congressman from the Nineteenth District, Champaign, Ill., has given bonds and stocks valued at $120,000 to the University of Illinois for the establishment of an infirmary for the use of the students and faculties of the institution.

The sum of $100,000 has been given anonymously to the Higher Institute of Medicine for Women at Petrograd for the foundation of scholarships in the name of Count Vorontzoff, who died in 1916.

For the period from 1911 to 1915, inclusive, the proportion of first places, according to reports of state board examinations published in the *Journal* of the American Medical Association, the percentage of first places won by the different schools of medicine is: Pennsylvania, 5.1; Johns Hopkins, 4.9; Harvard, 4.5; Northwestern, 4.4; Rush, 4.2, and Jefferson, 4.1.

Dr. Marion L. Burton, president of Smith College, has accepted the presidency of the University of Minnesota.

Dr. Edgar R. McGuire, of Buffalo, N. Y., has been elected to fill the chair of surgery in the medical department of the University of Buffalo, which position was previously held for thirty-one years by the late Dr. Roswell Park. Dr. McGuire was Dr. Park's assistant for several years and has been acting head of the department of surgery for the past two years.

A. C. Baer, instructor in dairy husbandry at the University of Wisconsin, has resigned to become head of the dairy department of the Oklahoma College and Station.

E. P. Taylor, professor of horticulture and horticulturist at the Utah College and Station, has resigned to become director of agricultural extension at the University of Arizona.

It is stated in *Nature* that Mr. Joseph Yates, of the Blackburn Technical School, has been appointed head of the chemistry department of the Derby Technical College.

DISCUSSION AND CORRESPONDENCE

THE FUR SEAL CENSUS OF 1916

I am indebted to the Commissioner of Fisheries for the following detailed enumeration of the fur seals of the Pribilof Islands for 1916:

Breeding females	116,977
Pups	116,977
Harem bulls	3,500
Idle bulls	2,632
Yearlings, both sexes	67,291
Two year olds, both sexes	48,460
Bachelors and young bulls	61,492
Total	417,329

This census is the work of Mr. G. Dalles Hanna, a member of the island staff, who also made the counts of 1915, given in the October 27 issue of Science. Mr. Hanna came to his work on the fur-seal islands in 1913 and participated in a considerable part of the work of pup counting of that season, thus becoming familiar with the methods employed. Comparing the two seasons for which he is responsible we find for 1916 a gain of 13 per cent. in pups, which is also the gain in breeding females. It will be remembered that in the two counts by the writer for 1912 and 1913, in which the personal equation was also the same for both seasons, a gain of 12½ per cent. was found for 1913. These two sets of counts go far toward fixing the normal rate of increase in the breeding stock of the herd at approximately 13 per cent. per annum.

A second significant thing about this census of 1916 is the item, "bachelors and young bulls, 61,492." These are males of less than adult age, three, four, five and six years. They represent the animals exempted from killing in the past five years by the law of 1912, suspending commercial sealing. These 61,000 animals have definitely passed into the reserve bull class and will as they gradually attain maturity constitute that dangerous overstock of breeding males which is resulting from the operation of the law of 1912. There were already present on the rookeries in the spring of 1916, 3,981 adult bulls in excess of the number holding harems in 1915. Of these 1,349 forced their way into the breeding grounds and established harems. A normal increase in harems would have been 280, equalling the 13 per cent. gain in cows. Even after these 1,349 had obtained harems there remained 2,632 adult bulls which were unable to obtain harems. It is unnecessary to say that these unsuccessful idle bulls as well as those which

were successful occasioned a large amount of fighting and confusion on the rookeries in the season of 1913.

Fortunately, Mr. Hanna has given us the data to illustrate just what this fighting and confusion has meant; he has supplied us with a count of the dead animals. Similar figures for 1915 are not available, but we have such figures for 1912 and they may be compared as follows:

Animals Dead	1912	1916
Bulls	3	12
Cows	27	79
Pups	1,060	2,482

The deaths in 1912 were what might be considered normal and inevitable. In that season there were only 113 idle bulls and the fighting was a negligible factor. The deaths occurred as a result of accidents inherent in the crowded condition of harem life. In 1916, however, we find the deaths among bulls quadrupled; among cows, almost trebled and among pups, increased 134 per cent. Moreover, this is with only between two and three thousand idle bulls. What will be the result when the 60,000 to 70,000 idle bulls begin six to eight years hence to bring their pressure to bear upon the breeding grounds?

In my report for 1913 I attempted, without effect, to bring this unfortunate aspect of the fur-seal law of 1912, which could readily be foreseen, to the attention of the Bureau of Fisheries in the following words:

> The bull fur seal is an animal of about 500 pounds weight; his mates are animals of 80 pounds weight; the pup at birth is a weak thing of 12 pounds. The harem life of the seals is crowded at best and subject to commotion. The mother seal takes no thought of the time and place of labor. Newly born pups are trampled and smothered under the best of circumstances. Anything which creates turmoil and fighting in the vicinity of the breeding grounds is necessarily fraught with danger to the young. Fighting among the bulls arises from attempts by idle bulls to steal cows from their more successful neighbors. In these contests cows are torn and injured and pups trampled. . . .

George Archibald Clark

Stanford University, Calif.,
January 23, 1916

PROFESSOR CURTIS'S REVIEW OF PETRUNKEVITCH'S MORPHOLOGY OF INVERTEBRATE TYPES

The review of Professor Petrunkevitch's "Morphology of Invertebrate Types" by Professor W. C. Curtis in Science for December 1 is rather misleading. The method of presentation in Professor Petrunkevitch's book is certainly one for which many teachers of invertebrate zoology have been waiting. Commendation of the principles upon which the book is founded and explanation of the necessity for such a work have been very ably put forth in Professor Curtis's review. However the method of presentation of subject-matter and type forms taken up for consideration are but two of the many points to be considered in determining the value of a book as a text for student use. It has been my experience, and I am sure it is shared by others, that one of the most difficult things to accomplish with the student in science is an appreciation of the necessity for clearness of expression. Mistakes in grammar and in English are too frequently looked upon as of no consequence to the scientist. In view of these facts I feel that the reviewer has omitted some points to which attention should have been called.

When Professor Curtis makes the remark that "the book is well done, clear, concise and to the point . . ." he very evidently does not consider such passages as:

> Place a specimen in a white dish with water on its right side and make a drawing twice natural size showing the left side (page 155).

On page 8 the student is directed to

> Label anterior and posterior end, dorsal and ventral surface.

Another example of what does not appear to be either clear or concise is found on page 39, where the reader is told that

> The *circular canal* follows the edge of the disc between every rhopalium.

I do not believe that a zoology text could be written in sufficient detail to eliminate the necessity of a teacher, but I do think that a large percentage of the average undergraduate class in studying the anatomy of *Molgula* would require an explanation on the part of

the instructor of the exact relations existing between the two structures "the tunique" and "the tunic" when that explanation could be avoided through greater consistency in the use of terms in the text.

Errors of a nature more serious than those just cited are not wanting in the text. In the discussion of the earth-worm the sperm sacs or seminal vesicles of the male reproductive system are called spermathecæ (misspelled spermothecæ three times on page 94). In so far as I have been able to determine the term spermathecæ is applied by morphologists and by specialists in the oligochætes to that part of the female reproductive system which Petrunkevitch calls the receptacula seminis. I doubt that readers of a review would consider errors of this type "of such a minor nature that to mention them might seem like petty criticism."

The all too frequent misspellings of words and inconsistencies in punctuation, in capitalization, and in the indiscriminate use of or omission of the hyphen in identical combinations of words, while items in themselves of but minor importance, impair the value of the book as one to be placed in the hands of undergraduate students, whose carelessness along these lines would tend to be accentuated. For some of these errors it is probable that the publishers are in some degree responsible. Granted that "it is not a work which gives the impression of having been carelessly put together," yet more care in proofing, in making certain of the correctness of the statements, and in the form of the expression would have added considerably to its value.

H. J. Van Cleave

SCIENTIFIC BOOKS

Discovery, or the Spirit and Service of Science. By R. A. Gregory. New York, Macmillan and Co. Price $1.75.

The appearance of this book could not well have been more timely. At the present date when all English-speaking peoples are in greater or less degree reaping the bitter fruits of their past indifference to the welfare of scientific investigation, a widespread awakening to the more immediate utilitarian advantages of scientific discovery is finding expression in the formulation of far-reaching governmental plans for the furtherance of technical research, research in other words that "pays." Our governors and leaders utterly lacking the viewpoint of the investigators and any consciousness of the larger import and ultimate aims and utilities of science are of course as indifferent as ever to the welfare or outcome of the more fundamental and far-reaching problems of research, for these can not be guaranteed within any defined period to return the several hundred or thousand per cent. which the political or commercial public naturally expects as the outcome of any investment in research. There is a manifest danger that the welfare of scientific investigation will actually suffer by reason of the new-born and ill-directed interest of the politician. This is an occasion, therefore, when it is more than ever necessary to undertake a definite campaign of popularization of the true aims and aspirations and methods of the scientific discipline of thought.

The educator, no less, perhaps, than the politician, requires instruction in the true aims and inspiration of science. In the words of our author, "The following pages will perhaps show that the spirit of scientific research has inspired the highest ethical thought and action, as well as increased the comforts of life and added greatly to material welfare. We seek to justify the claim of science to be an ennobling influence as well as a creator of riches; and therefore as much importance is attached to motive and method as to discovery and industrial development, however marvellous or valuable these may be." It may be added that the citations in this little book will perhaps serve to show our "humanistic" colleagues that science has been able to inspire literature which will bear comparison in nobility of thought and beauty of expression with the literary standard of the "humanities."

By a pardonable oversight on page 103 the Yerkes Observatory is situated in California.

T. Brailsford Robertson

The Relations of Mollusks to Fish in Oneida Lake. By Frank Collins Baker. Technical Publication No. 4, New York State College of Forestry at Syracuse University. Pp. 366.

The New York College of Forestry, under the leadership of Dr. Hugh P. Baker, takes a broad view of the subject in including not only the waters conserved by the forests, but also their animal life and economic resources. The present volume is concerned primarily with the molluscan food of fish, but a large part of it discusses the relations of mollusks to the rest of the fauna and the flora, the distribution and associations of species and other topics interesting to zoologists concerning themselves with fresh-water faunas.

It appears that mollusks form 31.5 per cent. of the food of 25 of the most important food and game fishes of the state. About half of the species of fish found in Oneida Lake are in some degree mollusk feeders. The fauna of the lake comprises upwards of 62 species and varieties of shellfish, nearly all of which are known to contribute to the piscine menu, but in varying degree. The little clams of the family Sphæriidæ appear to be a favorite article of diet, also such diminutive gastropods as *Valvata* and *Amnicola,* as well as the larger *Physa* and *Planorbis,* all these appearing in the food lists of many species. The large mussels, Unionidæ, are used by a smaller number of fishes. The whitefish, catfishes and pumpkinhead are notable for the large number of species of mollusks eaten.

The areas rich in life are confined to the shallows along the shores, usually not exceeding three fourths of a mile wide and twelve feet deep, affording an area of approximately 8,348 acres for feeding and breeding grounds for fish. In deeper water, vegetation is scarce or absent, and only scattered individuals of three species of mussels were taken with the crowfoot dredge. Possibly the total absence of gastropods was due to the form of dredge used; yet the same poverty of deep water was noted by Miss Maury in Cayuga Lake. It seems likely that the mollusks of these post-glacial lakes have not had time to become adapted to deep water conditions, as they have in the Swiss lakes and many other bodies of fresh water.

No general valuation of the total molluscan fish food of the lake is attempted, but there are some interesting estimates of limited areas, from counts made of selected plots of a foot square. A bowldery station 300×500 feet has a mollusk population of 7,650,000 individuals. On a sandy bottom area $1{,}000 \times 500$ feet the counts indicated 65 million. Finally, in the outlet, where there is a uniform area of fully $3{,}500 \times 500$ feet, there are estimated to be 304½ million mollusks.

The chief species are illustrated by photographic figures. Mr. Baker's work is well done, as we should expect from his long experience with freshwater mollusks, and his excellent volume on the North American Lymnæas. The book will be found a useful addition to the literature of freshwater zoology.

Henry A. Pilsbry

Academy of Natural Sciences of Philadelphia

SPECIAL ARTICLES

THE OVERLAPPING OF THE LEAF SHEATH AND ITS LACK OF VALUE FOR DESCRIPTIVE BOTANICAL LITERATURE

During the crop season of 1916 the writers grew, at Texas Substation No. 8, Lubbock, Texas, uniformly tall and dwarf plants of milo from the same seed, by varying the time of planting and the environmental conditions. Measurements were secured from both the tall and the dwarf plats, by taking ten consecutive main plants in an average row and recording the internode and sheath lengths. The total number of internode and sheath measurements amounted to 78 in the tall group and 93 in the dwarf group. The results showed the mean internode length in the tall group to be $13.33 \pm .061$ centimeters, as against a mean internode length in the dwarf group of $6.88 \pm .048$ centimeters. The mean sheath length was $17.46 \pm .050$ centimeters in the tall and $15.95 \pm .026$ centimeters in the dwarf.

Tall and dwarf plats of kafir were also grown from the same seed and a similar set of measurements, totaling 106 in the tall and 100 in

the dwarf, recorded in each case. The results in the case of kafir showed a mean internode length of 12.00 $\pm$ 3.599 centimeters in the tall group, as compared with a mean internode length of 6.89 $\pm$ .532 centimeters in the dwarf group. The mean sheath length in the tall group was 18.01 $\pm$ 3.81 centimeters and in the dwarf group 18.02 $\pm$ .322 centimeters.

It is seen that in both milo and kafir the internode length varies widely when the plant is grown under different environmental conditions, but that little variation has occurred in the length of the sheath.

From these data it would seem that overlapping of the leaf sheath may show wide variation in other Gramineæ in the same variety and plant from year to year, depending on environment, and that a statement of the overlap of sheath in descriptive botanical literature is of doubtful value.

A. B. Conner,
R. E. Karper
Agricultural Experiment Station,
College Station, Texas

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORT OF THE TREASURER FOR 1916

In compliance with Article 15 of the constitution, and by direction of the council, the treasurer has the honor to submit the following report showing receipts, disbursements and disposition of funds and securities of the association for the year 1916 up to December 20, inclusive.

Receipts have come into the keeping of the treasurer from the following sources:

(*a*) From interest on deposits with the United States Trust Company of New York, N. Y.
(*b*) From the executor of the estate of Richard T. Colburn.
(*c*) From interest on securities purchased for the association during the year.

The total of cash receipts during the year is $54,760.24; and the appraised value of the securities received from the Colburn estate is $25,740. The grand total of cash receipts and appraised value of securities received is $80,500.24.

Disbursements made in accordance with directions of the council amount in the aggregate to $77,027.87. These include $75,733.98 paid for $80,000 worth, par value, of securities purchased for the association and held as an investment.

The total amount of funds of the association, consisting of cash, cost value of securities purchased and appraised value of securities received from the Colburn estate, is $109,151.21.

The details of receipts, disbursements and disposition of funds are shown in the following itemized statement:

BALANCE SHEET

Assets

Investments:	
Securities (see schedule, page 146)	$100,777.50
Cash in banks	8,373.71
	$109,151.21

Liabilities

Life-members (284 at $50)	$14,200.00
Jane Smith Fund	5,000.00
Colburn Fund	77,755.74
	$96,955.74
Accrued surplus	$12,195.47
	$109,151.21

The Treasurer in Account with the American Association for the Advancement of Science

Dr.

1916		
Jan. 1.	Balance from last account	$30,641.34
Feb. 4.	Cash from Colburn estate	51,265.74
Feb. 4.	Bonds from the Colburn estate (appraised value)	25,740.00
May 6.	Cash from Colburn estate	750.00
July 1.	Interest from United States Trust Company	764.50
	Interest on securities for the year	1,980.00
		$111,141.58

The Treasurer in Account with the American Association for the Advancement of Science

Cr.

1916		
Feb. 4.	Bonds from Colburn estate (appraised value)	$25,740.00
Apr. 26.	Amount paid permanent secretary for two life memberships under Jane M. Smith Fund	100.00
Apr. 27.	Grant to Concilium Bibliographicum	250.00
Apr. 27.	Grant to Ralph C. Benedict.	100.00
Aug. 2.	Interest on life memberships for 1914 and 1915	793.89
Nov. 15.	Compensation paid United States Trust Company for services in purchase of bonds	50.00
Aug. 17.	Securities purchased, listed as follows:	
	$10,000 Chicago and Northwestern Railway Co. 4 per cent. bonds $9,425.00	
	Accrued interest 102.22	

$10,000 Atchison, Topeka and Santa Fe Railway Co. 4 per cent. bonds...	9,287.50	
Accrued interest	135.56	
$10,000 Great Northern Railway Co. 4.25 per cent. bonds	10,050.00	
Accrued interest	37.78	
$10,000 Pennsylvania Railroad Co. 4.5 per cent. bonds	10,487.50	
Accrued interest	2.50	
$10,000 Chicago, Burlington and Quincy Railroad Co. 4 per cent. bonds ...	9,350.00	
Accrued interest	177.78	
$10,000 Union Pacific Railroad Co. 4 per cent. bonds	9,012.50	
Accrued interest	170.67	
$10,000 Northern Pacific Railway Co. 4 per cent. bonds	9,187.50	
Accrued interest	37.89	
$10,000 New York Central and Hudson River Railroad Co. 3.5 per cent. bonds	8,237.50	
Accrued interest	32.08	
		$75,733.98
Dec. 20. Cash in banks as follows:		
Fifth Avenue Bank of New York	$1,681.34	
United States Trust Company of New York	6,692.37	
		$8,373.71
Total		$111,141.58

SCHEDULE OF INVESTMENTS

Securities Purchased

Par Value	Purchase Value	
$10,000 Chicago and Northwestern Railway Co. general mortgage 4 per cent. bonds, due 1987	$9,425.00	
$10,000 Atchison, Topeka and Santa Fe Railway Co. general mortgage 4 per cent. bonds, due 1995	9,287.50	
$10,000 Great Northern Railway Co. first and refunding mortgage 4.25 per cent. bonds, due 1961	10,050.00	
$10,000 Pennsylvania Railroad Co. consolidated mortgage 4.5 per cent. bonds, due 1960	10,487.50	
$10,000 Chicago, Burlington and Quincy Railroad Co. general mortgage 4 per cent. bonds, due 1958	9,350.00	
$10,000 Union Pacific Railroad Co. first lien and refunding mortgage 4 per cent. bonds, due 2008......	9,012.50	
$10,000 Northern Pacific Railway Co. prior lien railway and land grant 4 per cent. bonds, due 1997	9,187.50	
$10,000 New York Central and Hudson River Railroad Co. 3.5 per cent. bonds, due 1997	8,237.50	
		$75,037.50
Appraised value of bonds received from Colburn estate		25,740.00
		$100,777.50

R. S. Woodward,
Treasurer

December 20, 1916

THE AMERICAN ASTRONOMICAL SOCIETY

The twentieth meeting of the American Astronomical Society was held at Columbia University, on December 26–29, 1916, in connection with the Convocation-week meeting of the American Association for the Advancement of Science. The attendance was large, forty-nine members being present, but was unevenly distributed geographically, two thirds of those present coming from the New England and Middle States, and only two from west of the Mississippi.

By an unusual coincidence, three of the most important communications from the standpoint of astronomy were not made at the sessions of the Astronomical Society. Professor Campbell's admirable address on "The Nebulæ" was delivered by him as retiring president of the American Association for the Advancement of Science at a general session; and the no less interesting addresses of Professor Brown, on the relations between mathematics and the physical sciences, and of Professor Leuschner, on the determination of orbits, were presented at a joint meeting of the American Mathematical Society, the Mathematical Association of America, the American Astronomical Society and Section A of the A. A. A. S.—which organizations also joined in a very enjoyable dinner on Thursday evening. As these three addresses will doubtless be published *in extenso,* it is of no use to summarize them here.

At the regular scientific sessions 35 papers were presented, which are here grouped according to their subject matter, rather than the order of presentation. Beginning with the mathematical and instrumental aids to investigation, Hedrick exhibited specimens of new tables for rapid interpolation of logarithmic and other tables, while Schlesinger, discussing the error arising from "neglected decimals," showed that this is usually

very small; amounting, indeed, more often than not to but a single unit of the last tabulated decimal place, unless the number of tabular quantities which have been combined exceeds twenty. Plaskett showed very interesting views of the construction of the great 72-inch telescope, and of the observatory placed on Saanich Hill, Vancouver Island. The work is now practically completed except for the installation of the great mirror.

In connection with the photographic work for which such great telescopes are mainly used, F. E. Ross's paper, showing the superiority of some kinds of developer—notably "caustic hydrochinon"—in securing sharp star images, and King's which showed that, when an exposed plate is kept for months before development, the strongest images on it grow more intense, while the weakest ones fade, are of importance. The discussion of Flint's paper on systematic errors in the determination of stellar parallax brought out an apparently general confidence in the reliability of the modern photographic determinations. In other fields, Urie described records showing that the government wireless time signals sent out from the Great Lakes station are, very consistently, about one twelfth of a second later than those sent from Arlington—this "lag" representing the time which the signals from Washington take to reach the more distant station over the telegraph lines. Russell computed that the minimum radiation visible to the eye carries energy at the rate of but one erg in forty years.

There were relatively few papers dealing with bodies in the solar system. Bauer summarized the latest results of the ocean magnetic work of the Carnegie Institution; Slocum showed a fine series of photographs illustrating the librations of the moon; Father Rigge discussed the eclipse of December 13, 1917, which will be centrally annular almost exactly at the South Pole; Very described the complications which the absorption of the earth's atmosphere introduces into the determination of the temperature of the moon; Arctowski gave the results of recent work on sun-spots, and brought out the remarkable fact that at Batavia, Java, the weather tends distinctly to be unusually rainy on days of magnetic storms—which, with other facts, falls in well with the belief that the magnetic disturbances are caused by the impact of electrically charged corpuscles on the earth's atmosphere; and W. E. Glanville described and discussed his observations of the zodiacal light.

As has been usual in recent years, many communications dealt with stellar astronomy. Benjamin Boss and his colleagues von Flotow and Raymond contributed six important papers on stellar distribution and drift. It was found that the brighter naked-eye stars tend to congregate, not only towards the galactic plane, but toward a subsidiary plane inclined about 50° to the former; that in certain regions of this belt of bright stars there exist tendencies toward systematic motion of a type not present elsewhere; that near the south galactic pole the whiter and redder stars are, for the most part, moving in different directions; that the stars of large proper motion tend to move parallel to one or other of two mutually rectangular planes in space; that in some cases the parallaxes of these stars can be estimated with considerable accuracy on the basis of these motions, and so on. Two papers by Shapley and Pease dealt with star-clusters, one giving evidence that the great cluster in Hercules is not strictly globular, but ellipsoidal, and the other announcing several important observations, especially that many of the very faint stars in the clouds which compose the Milky Way are bluish-white (which is not the case in other parts of the sky), and that it is therefore probable that the distance of these star clouds is much more than ten thousand light years. Seares (likewise from Mount Wilson photographs) finds that the number of stars per square degree in the center of the Milky Way is more than twenty times as great as near the galactic poles—a result in remarkable and still unexplained discordance with the ratio of four to one obtained at Greenwich.

Another group of communications dealt with variable and double stars. Leon Campbell exhibited the remarkably successful cooperative work of amateur observers in following the peculiar variable *SS Cygni;* Kunz and Stebbins reported the discovery of two new variable stars in Orion—one of them, *Eta Orionis*, a bright star, with variation due to eclipse. Bailey discussed the light-curves of cluster variables; Dugan gave a preliminary account of his observations on the eclipsing system *U Cephei*, which shows a conspicuous secondary minimum; and Miss Cannon, describing the spectra of this same star, reported that the bright component was of Class A, and the larger but fainter one which totally eclipses it of Class K—so that these two stars, though separated by little more than the diameter of either, are spectroscopically as unlike as Sirius and Arcturus; and Russell presented orbits of the visual binaries ϵ *Equulei* and Krueger 60—the latter the faintest and least massive star whose orbit has so far been computed.

Three important papers on nebulæ close the list.

Van Maanen finds for the planetary nebula N.G.C. 7662 a parallax of 0″.023, making its distance 140 light years, and its diameter about twenty times that of the orbit of Neptune; Newkirk, from a splendid series of Lick photographs, concludes that the ring nebula in Lyra has no sensible parallax or proper motion, and must be of enormously great size; and Wright, with the new Draper quartz spectrograph of the Lick Observatory, finds evidence of continuous spectrum in the extreme ultraviolet in the planetary nebulæ, and gives good reasons for attributing it to hydrogen in the gaseous state. A fourth paper, on the rotation of planetary nebulæ, had to be read by title, on account of the regretted illness of its author, Professor Campbell.

Little formal business came before the meeting, as most of this had been attended to at Swarthmore in August. A committee upon observation of variable stars was created, to cooperate with and extend the excellent work which is now being so extensively done by amateurs. A special committee constituted to consider and make a public statement upon the widely discussed "Daylight Saving Plan" reported as follows:

"1. The chief objects the daylight saving plan hopes to accomplish are: (*a*) to facilitate earlier rising in summer than in winter; (*b*) to increase the hours of daylight available after the day's work for recreation or other purposes; and (*c*) to conserve to the nation as a whole a part of the fuel now being consumed in the production of artificial light.

"2. The plan which has been proposed for the United States, and which has been adopted as a war measure in England, France and Germany, as well as in Holland, consists in advancing the legal time one hour during part of the summer half of the year. In the United States this amounts to a simple shift of the boundaries of existing standard time zones.

"3. In order to be of real benefit, the plan must be adopted simultaneously by a large majority throughout an extended area of the United States.

"4. It is to be noted that the advantages of the plan become less as we approach the extreme southern part of the country, because the hours of daylight are more nearly the same throughout the year in lower latitudes. For this reason, this committee suggests that a modification of the proposed plan might be advisable for the extreme southern portion of the United States.

"5. If daylight saving is adopted, this committee recommends that, in order to obviate the introduction of terms that may prove confusing, the names now in use to describe standard time be continued with unchanged meaning, thus in Chicago Central Time would be used in winter, as at present, and eastern time in summer.

"6. The proposed plan involves no advantages in scientific work, nor does it entail serious disadvantages. Meteorological observers would continue the present practise of making their observations at specified Eastern Standard times throughout the country. The change in time could easily be taken into account in the preparation of tide tables and similar publications.

"7. The chief objections to the proposed plan that have been brought to the attention of the committee are the following:

"(*a*) In all civilized countries the middle of the working day is not noon, but somewhat later. Under the proposed plan it would sometimes come before noon, and usually earlier than the experience of mankind appears to have justified.

"(*b*) Artisans who begin work early would have to get up in the dark, thus undergoing serious inconvenience, and at times using more instead of less light, and also at some seasons requiring more fuel.

"(*c*) The setting back or forward of all clocks by an hour on two days in each year will involve inconvenience and annoyance.

"(*d*) 'Not a single scientific society or other body with expert knowledge has supported it' (*Nature*).

"8. The committee are unanimous in regard to sections 1 to 6 above, but are not agreed as to the weight that should be attached to the disadvantages enumerated under 7. Two members, Jacoby and Schlesinger, favor the adoption of the plan as proposed, and are convinced it would be highly beneficial; a third, Poor, believes that the plan should be put into operation, but for the present as an experiment. The two remaining members, Pickering and Russell, believe that the disadvantages distinctly outweigh the advantages, and are opposed to the adoption of the daylight saving plan."

It may be added that a vote at one of the meetings of the society showed eight members in favor of the plan, seven opposed to it, and fourteen neutral.

With resolutions of thanks to Columbia University for the hospitality extended to the society, the meetings came to a close on Friday afternoon, December 29.

Henry Norris Russell,
Acting Secretary for the Meeting

SCIENCE

FRIDAY, FEBRUARY 16, 1917

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THE OUTLOOK FOR AGRICULTURAL SCIENCE[1]

WITHOUT wasting time in discussing the question whether there is such a thing as agricultural science, I desire to proceed at once to a brief review of the conditions both favorable and unfavorable to the progress of those scientific activities necessary to the improvement of American agriculture and the welfare of country people upon whom we all depend for our food supply, for the proper employment and treatment of our lands, and for certain human qualities best propagated and preserved in the life of the open country.

THE PLAN

No thinking man can fail to be deeply impressed with the magnitude and the far-reaching consequences of what might be called the American program for agricultural advancement.

This program took definite form in 1862 in the establishment of a national Department of Agriculture, and in the passage of the Land Grant Act, whereby a college of agriculture was established in every state of the union. It was characterized and vitalized a quarter of a century later by subsequent acts providing for an experiment station in connection with every agricultural college; and mightily advanced by state appropriations, in some instances multiplying many times the federal subsidy. So generous indeed were these appropriations that the $30,000 of federal funds

[1] Address of the vice-president and chairman of Section M, Agriculture, American Association for the Advancement of Science, New York, December 27, 1916.

have been supplemented until the total revenues of certain institutions for agricultural research amount to no less than $200,000 annually.

This combined federal and state program aims directly at an adequate and a permanent food-supply, and with equal directness it proposes to retain upon the land, if possible, a fair share of the intelligence, the learning, and the culture of the American people. This latter purpose may be called Utopian, but a little reflection will convince even the most skeptical that in no other way can our lands be properly handled, for farming is after all and in the last analysis an individual affair.

The incidental effect upon citizenship of such a systematic effort, especially in a democracy, is an interesting sociological and economic question, but it is quite aside from the present purpose, which is to analyze the agencies that have been awakened in the name of agricultural science and to distinguish as clearly as possible between those that are really helpful and others that by accident or otherwise have become attached like barnacles to the ship and whose load is even less serious than their resistance.

The sudden establishment of a national system of fifty institutions under combined federal and state support, and the engaging upon this extensive scale in both education and research in a hitherto neglected, if not despised, field was certain to be followed by results both desirable and undesirable. The combination is still further complicated by the fact that the new field has suddenly become popular, drawing into its vortex amounts of money never before equaled, and engaging the attention of all sorts and conditions of men, some seeking opportunity for real service, others attracted by the loaves and fishes, even by the crumbs.

It was as inevitable that certain results should follow the agencies here invoked as that other effects should follow causes.

For example, it is impossible to launch so pretentious a program without a vast amount of good resulting, and in this respect the most sanguine enthusiasts have not been disappointed. It is impossible to accomplish a public service of this character and magnitude without developing a body of earnest, capable and devoted scientists who work, not for reward, but for the good that they can do, and it is my desire here and now to pay tribute of respect to the hundreds, yes thousands of men and women who labor both day and night, who expose and often destroy their health in carrying forward this great work. They shall have their reward.

But it is also impossible to suddenly engage upon an extensive scale in a new and undeveloped field without drawing into the service both inadequately trained and mediocre men. It is impossible that a field should be popular without attracting the sensationally minded, and it is equally unlikely that so large an amount of public money could be expended without the creation of a vast and complicated administrative machinery.

It is for us who have been in this work almost from its beginning and who have seen with our own eyes both the wheat and the tares developing side by side to critically and somewhat sharply distinguish between the two. Not only should we do this among ourselves, but, difficult and unpleasant as the service is, we owe it to the public, we owe it to our institutions, and we owe it to ourselves to frankly state the conditions as they are, with a view to the correction of certain evils that have crept in and which, if not exterminated, will destroy not only the best work in agricultural science, but even the institutions that were founded and are operated for its advancement.

THE FIELD

It can not be too thoroughly and universally understood and remembered that for the purpose of research, teaching and demonstration, agriculture means farming. Agriculture is so broad a term; it touches so many sciences and at so many points; its problems are so varied and the questions involved in their solution are so fascinating that the temptation to wander far afield is often well nigh irresistible.

However, the funds appropriated, whether public or private, were set aside for the express purpose of improving the quantity, quality, reliability and permanency of our food supply and for the welfare of those who work the land and who, experience shows, rapidly descend to the level of peasantry under conditions which they are unable to control without the assistance of science, the benefits of education, and the support of the public conscience.

Wherefore, we are to distinguish sharply between those lines of investigation that bear upon the business of farming and those collateral lines which, though they may arise out of the materials of agriculture, have yet little or no significance in the field of food production.

In saying this the writer is not to be understood as restricting the field to so-called practical lines. Far from it. For this purpose at least there is no distinction between what is practical and what is scientific. But let the scientist be not deceived by the materials with which he works. It is not the materials that determine whether a piece of work is truly agricultural; it is the outlook, the purpose, the application that is to be made, these are the tests, not as to the excellence of the work or its general significance, but as to its legitimacy, especially in the experiment stations.

Wherefore, these funds are not available for ordinary scientific research, however valuable, even though the materials involved be drawn from the farm. They are not available for the amusement or the personal enjoyment of the investigator; neither are they to be devoted to paying the expenses of aviation excursions into the rarefied and upper atmosphere of speculation even in so worthy a field as the so-called pure sciences.

The temptation to wander afield is not only due to the fascination of outlying pastures, but it is strengthened by the actual and frequent necessity of spending much time and energy in clearing up an abstract point which science in its imperfect state has not yet touched. But these excursions into outlying territories after truth necessary for purposes of further research are to be regarded as essential rather than logical; as a means to an end and never a purpose. At no point does the research man in agriculture need to step permanently aside for facts which science has not yet supplied, but which he must obtain before going ahead with his proper work.

MEN

Fortunately for some reasons, unfortunately for others, the time has come when agriculture is popular. Among the fortunate features of so happy a condition of affairs is the fact that we now command in this field the respect and the service of the highest grade of men with the best obtainable training. And if some are yet tempted to enter this form of service in the hope of premature, if not undue publicity, we have the satisfaction of believing that their numbers are growing relatively smaller.

Indeed, as matters stand to-day it would be difficult to find in any other branch of human activity a more self-sacrificing and public-spirited class of men than are those of our agricultural colleges and experiment stations. They have had some trouble, it is

true, in obtaining in all cases suitable training, but their spirit and energy are certainly laudable, even calling often for restraint in the interest of health and the higher service.

A heavy weight of responsibility rests upon the young man now preparing for a career in agricultural research. It is not enough that he have some special knowledge and skill in a narrow field such as soil analysis, genetics or vegetable pathology. He must have scholarship, breadth of knowledge and vision enough to know the relation of his specialty to other branches of science, and the bearing of it all upon the business and the practise of food production, that is, farming.

For the purposes of the investigator a real knowledge of and sympathy with the actual operation of the farm and the problems of the farmer is not only desirable, but essential. Farming is a productive, not a speculative industry, and the problems of agriculture are those of production and distribution, not those of special opportunity.

Moreover, farming is a private business upon which the welfare of families depends—not a few scattered people, but a full third at least of all the population and constituting entire communities. This fraction of the race must not be disregarded or the earth will avenge herself not only upon the unsuccessful farmer, but upon the people as a whole, whose heritage, after all, the land is.

The agricultural scientist, therefore, must not make mistakes, or he will lead a whole people to disaster. Our philosophies may be wrong; they can be readjusted. Our conceptions of the solar system may be incomplete or wholly erroneous; but everyday life will go on about the same. However, if we entertain wrong conceptions about the serious business of food production, the consequences are swift and merciless.

If we get too little out of the earth, population is unduly restricted or unutterably miserable; and if we win our sustenance by methods destructive rather than permanent, then our successors, if not we ourselves, will pay the penalty of our error or of our piracy. Science is our only reliance, but the agricultural engineer must make no mistakes. He must be no blind leader of the blind. Therefore he must know the business of farming.

Now this is easier said than realized. The college student has lived all his life in school. Learning has been his occupation. Moreover, we shall tell him that if he expects to be really valuable, he must not stop with the bachelor's degree, but he must do so much in addition and do it so well that he will inevitably and in good time achieve the doctorate.

How then can this young man know by experience the business of farming? He can not know it as the farmer knows it after fifty years of earning a living and of clothing and educating the family he has raised. This prospective scientist will work for a salary, which means an assured living while he studies and attempts to solve the problems of those who live by production.

The problem for the young scientist is not easy, and that is the reason for discussing it at length. It takes twelve years of child life to finish the high school and prepare for college. The student is twenty to twenty-two at graduation. Three years more for a doctorate puts him at twenty-three to twenty-five. Besides, there is marriage to be considered, for farming is a married man's job, and bachelors as a class will never solve its problems. When and how is this man to get experience in actual farming?

Experience in supporting a family on

the farm he can not have unless he owns a farm and becomes a real farmer, in which case he is out of our reckoning, for observation shows that such men are not likely to return to the public service except after failure, when they are not desirable.

It is impracticable, in the opinion of the writer, to require farm experience as a condition either of admission to college or of graduation, largely because of the difficulty of ascertaining and certifying what constitutes satisfactory experience; but it is possible to require actual farm experience as a prerequisite to certain elective courses of instruction, leaving the teacher to determine sufficiently for his purpose a question that has no complete solution.

It has long been the custom of the writer to advise every student in agriculture who has not lived a full year in actual work upon a real farm to drop out in the middle of the sophomore year and get it. This particular time is recommended as affording enough scholarship to enable him to look at the matter from the student's point of view, as being less valuable than later years, involving less embarrassment to the student, and as calculated to greatly enrich the later years of study. This is recommended for all students of agriculture, whether headed for farming or for a scientific career; and without at least this much of actual touch with real rather than paper farming, the future usefulness of the experiment station man is far from assured.

Much space is devoted to this subject because it looms large in public affairs just now. In conversation the other day with the most prominent Hindoo philosopher now living, and whose son graduated in the agricultural college of the institution I represent, this extensive landholder complained of the lack of practical knowledge or even of appreciation of the conditions actually and necessarily confronting the Indian farmer on the part of men in the public service and presumably qualified to advise and assist the people with an improved solution of their very difficult problem. They know certain scientific facts as abstractions, but to be useful somebody must make the application to practise and this application should be made by educated men.

No conception needs to be more firmly impressed upon the young agricultural scientist at this juncture than the fact that agricultural research is not a game for the amusement of the players, but a real search after truth to be employed in the solution of one of the profoundest of human problems, whether regarded from the standpoint of the individual farmer on his farm, or of public service to a people at large—consumer and producer alike.

VERIFICATION

One encouraging feature of the problem is the fact that the findings of scientists are to have abundant and able verification or correction in the field.

The thousands of farmers who are reading the bulletins of the experiment stations, the hundreds of agricultural students going from our fifty colleges and a growing number of schools back to the farm are all putting to the test, and intelligently too, under a vast variety of conditions, the tentative findings of the specialist. Here lie both safety and inspiration, but the obligation of the scientist to be always and everlastingly right is not lessened.

The business of verification is still further extended and intensified by the system of local improvement associations or farm bureaus, each employing an adviser who, when competent, as he commonly is and as he always ought to be, forms a nucleus for really effective service in actually putting to the working test whatever is new or promising in the business of farming. Fortunately the relations be-

tween the system of advisers and the experiment stations and the colleges of agriculture are very intimate. It looks as though in them the machinery at least for improved and reliable food production is fairly well assured.

POLICE WORK

However, there are always perils in the most promising journeys into unexplored territory or in sailings upon uncharted waters.

The experiment stations are new, and fortunately whatever else may be said they have now the confidence of the farmers, who have come generally to feel that a new force is in affairs and that a new help to farming has appeared in that indefinite thing we call service.

Now there is always a temptation to put sacred things to ungodly uses, and the experiment stations have not escaped the operation of the general law. Science has shown that a certain disease or pest can be controlled, and it has pointed out the method of doing it. What more natural than that the public should take the stations at their word, and say "Very well, here is an appropriation; go ahead, make your serums and your rules to put the thing into practise; hale citizens into court; fine or imprison them if necessary, but make it work"?

Now this is hasty logic and bad practise. The experiment stations are organized for research, not for administration. Again, it is unseemly that a creature of the public like a scientific institution should appear against citizens in the courts and fine or commit them to jail. Besides, the experiment stations have no militia with which to suppress resistance, which in such cases as foot and mouth disease is as ever present as time and as explosive as a volcano.

Besides, the object of the scientist is research, and how shall the experiment station carry on further investigation after new truth if it must stop short and enforce the accumulating mass of revised practise. It will soon be so cluttered up under such a policy that new work is impossible and most of its funds and laboratory space will be used for the purpose of "regulatory work," when further progress is practically impossible, a condition that has already overtaken certain of the experiment stations and is all too rapidly threatening others.

The only safety either to the research worker, the station or the public is for the investigator to verify his discoveries, point out the method of their practical use, and go on after other truths, leaving the public to make such use of the new knowledge as it deems wise and relying upon the usual police power of the state for its enforcement, if enforcement is necessary. In no other way can research be protected; in no other way can the stations discharge the public service for which they were organized; and in no other way can the confidence of the public be indefinitely enjoyed.

THE CULT OF ADMINISTRATION

The rate and the intensity with which administration under one pretext or another is coming to dominate research in this country, especially along agricultural lines, is little short of appalling to any candid observer who takes stock of the situation and who has the courage of his convictions.

Many if not most investigators in agriculture are now required to begin a piece of research work by drafting a formal project in which the materials and methods are definitely described, the cost specified, and the expected results foretold. The method is akin to a new turn of a kaleidoscope, or the setting of a new combination on a complicated machine which, after all the new adjustments of pins, screws and levers have been carefully made, is expected to go

ahead of itself and grind out what might be called inevitable results.

This process is intended as a standardizing procedure, and if results are not soon forthcoming, reports of progress are due from time to time as a kind of perpetual guarantee, on the installment plan, that the thing was worth doing and that the specialist is still "on the job" and not loafing or skylarking off into the wilderness fishing and hunting as scientists are prone to do!

Before anything can actually be done, however, this project, in many branches of the public service at least, must be submitted to administrative review, in order to learn whether the work, however valuable, can be legally performed. I confess to extreme difficulty in treating this portion of my theme with such moderation of language and statement as are appropriate to the dignity of the occasion, and when I fail let the exigency of a just cause be my excuse.

A mass of hirelings called clerks now pounce upon the project, one after the other, each intent, not upon helping forward a valuable piece of public service, but upon seeing if perchance he can not find some statute law, court decision or office ruling that makes the thing illegal and therefore impossible.

In this enterprise the hireling will take no chances. He is not there to promote the public service, but to regulate it, and to see that everything is done decently and in order. If service is prevented altogether, that is no business of his. Everybody must justify his job, and the more things get stopped the more importance is attached to restrictive methods. If everything goes through, many clerkships would be abolished.

Nor should this hireling be condemned when he reports adversely upon a perfectly good thing because it perchance runs counter to the ruling of a public official, even though made many years before in another department under conditions quite dissimilar and by a man of questionable ability, long since dead and practically, if not entirely, forgotten. This clerk was put there to find objections, and it is little wonder that he discovers among the accumulation of laws, decisions and rulings reason enough for stopping many of the things that come his way. After this arbitrary fashion is progress made unduly difficult.

When this project returns to the specialist, battered and beaten, he sets about to reconstruct the plan, using so much of the original as may have passed the various censors, introducing new material to fill the gaps, and sends it out again to run the gauntlet. After repeated journeys and final approval, the real worker at last sets about the task of endeavoring to accomplish something.

But the troubles of the investigator have only begun when the project is finally approved. He needs some new and special equipment and makes out a requisition in quintuplicate and three colors, praying His Majesty the Purchasing Agent to provide the materials for his work—of course out of funds already set aside for his department.

At the best, he must satisfy the business office that no other equipment will answer his purpose and that no other can be bought so cheaply. At the worst he may find that his specifications have partially or entirely been ignored and material ordered which he can not use, and often, through unfamiliarity of "the office" with the tricks of the trade, he is actually mulcted in the purchase.

But this poor project is not through with its troubles. The would-be investigator learns that the purchasing agent is not, after all, a free moral agent, but is himself an hireling. He learns that even the board of trustees, which was elected by the people to operate the university, are not free to use

their judgment, but have certain overlords at the state capitol in the form of special commissions appointed by the governor, and represented mostly by clerks empowered by law to ride rough shod over all conditions.

He finds—this scientist and would-be public servant—that his requisition for equipment must first of all be sent to the board of prison industries in order that anything made in the penitentiaries of the state may be substituted for his specifications, and that too regardless of price, over which neither he, nor the purchasing agent, nor even the board of trustees, has the slightest authority or even influence.

And still his troubles are not finished. Unkindest cut of all, he may not even select the assistant upon whose skill and faithfulness the outcome will largely depend. This assistant, secretary, clerk, or stenographer, whatever he may happen to be, will be selected upon examination by an outside body miles away, consisting of men appointed under half the salary of the investigator—and glad to get it—men who were never in his or any other man's laboratory, yet who presume to say and do say who shall be employed and who shall not be employed.

Not only are assistants appointed from without, but that form of administration which consists of reviewing projects or other supervision is performed by men appointed after the same manner. In this way it often happens that a mediocre neophyte "supervises" the investigations of his own teacher who was indiscreet enough and tender-hearted enough a few years ago to give him a passing mark against his own better judgment.

As a final blow to his personal pride and enthusiasm, this investigator learns that he will be unable to report his results in the form he most desires because the state printer or the prison shop is unwilling, or what is more likely unable, to do the work as it should be done, neither will they "release" the job that it may be done as it would appear in ordinary work from institutions not overriden by administration.

He even learns that the very building in which he works, and whose insufferable ugliness and unnecessary cost have amazed him, was planned by a state architect, overruling the supervising architect of the university; and that the building across the way, of another form of ugliness and inefficiency, was executed by another state architect of a succeeding "administration," again overruling the institution, its school of architecture, and its board of trustees, even though the autocrat knew so little of his business as to be unable to draw plans and specifications upon which builders would file a bid. So do administration and law prevail over knowledge, needs and reason, for this is an actual experience.

This investigator, discouraged, disgusted, if not disheartened at least with the keen edge of inquiry long since dulled, says in his heart: "I will arise and hie me to another institution where the needs of the work are held supreme over methods of procedure and exploitation of positions and funds."

Vain hope! He may find temporary relief at certain points, but it is only temporary, for the conditions described, while not all as yet operative in any one place, are every one in operation to-day somewhere among institutions given to agricultural research and are rapidly extending to all the publicly supported institutions.

As a last example of the absurd extent to which administration has been pushed, this investigator—qualified by long years of training and experience—will find, in not one but many institutions, that should his duties lead him outside the confines of his

state, he may not go at public expense *without the permission of the governor.*

His own knowledge of the needs, his training, judgment and loyalty count for nothing. His desire to economize funds, dearer to him than to anybody else, funds that have been exploited time and again by officers over whom neither he nor the board of trustees have the slightest control—this desire is no guarantee of his judgment. The opinion of the head of the department does not count. The recommendation of the president is void of meaning. The action of the board of trustees is impotent. The question must go to the governor of the state—this mighty question as to whether Dr. Blank, scientist at $4,000 per year, may step across the border to consult his brother scientist and have his expense bill of $7.93 paid from funds appropriated by the legislature and set aside by the trustees for this very purpose. Ye gods, where are we drifting!!

If this burden were from within the institution the case would be different, because it could the more easily be removed. But it is inflicted from without under the pretext of auditing, or of efficiency, and with certain federal funds we have reached a stage of affairs such that the specialist may work only in "cooperation" with offices a thousand, perhaps two thousand, miles away and represented by men who know little of the local conditions involved—a cooperation at best that is purely administrative, mostly restrictive, wholly artificial, and defensible only as a means of administration. So has administration become not only supervision, but actual cooperation, under which the last opportunity for personal initiative and the best service is taken away.

All this is done in the name of one or the other of two agencies—the administration of public funds, or the demands of efficiency.

Officers connected with federal and state administration seem to be unable to distinguish between the business of auditing and that of supervision. They reason that if they are in any way to certify funds they must also approve the work. In this way has ordinary auditing developed within twenty-five years into what was at first inspection of work and at last a kind of "cooperation" in which the one to be held responsible for results is under the dominance of authority entirely outside the institution which he serves. In this way an outside individual, even a minor officer, is able to overrule a university and its entire administrative machinery.

Efficiency is more insidious, for it works under the guise of service and proves by figures that scientists, teachers and others in the public service must be standardized in order to be made efficient, and before this car of Juggernaut, training, loyalty, counsel, experience, even deliberative acts of boards of trustees of successful and high-minded citizens serving without salary do not count as against a small group of self-selected and politically appointed individuals shut up in an office miles away with neither special training, knowledge of the situation nor other qualification to enter our laboratories but the blind authority of law working in the dark and largely through individuals who would never, except by the accidental working of law, be connected in any way with our work. So are useless and pestiferous positions multiplied and made parasitic upon a most excellent service.

LITTLE ADMINISTRATION NECESSARY

Administration can not vitalize research. Its whole effect is restrictive and hence should be reduced to a minimum. That it

is not necessary to good work is shown by the seventy-five years' experience at Rothamsted. That auditing accomplishes all that is necessary in addition to the public reports of responsible boards of trustees is shown by the experience of numerous institutions not yet under the blighting effects of too much administration. That administration is recognized as a deterrent to good work is shown by the struggles of the state universities everywhere, not only to free themselves from this outside dominance that is wasting funds, and crushing the life out of institutions and men, but they are also simplifying their own internal machinery to the end that nothing should come between the worker and his work.

All progress in science is the result of individual interest, initiative, invention and energy, all of which must be resident in the worker. The driving force that brings results is internal, not external, to the explorer after new truth. It beckons from ahead and does not prod from behind. It is akin to that attraction which drew explorers time after time to the pole, and not akin to the whip that sends the slave to the galley or the cotton field.

Administration does no work. It is a harness put upon activity. Its purpose is not to actuate, but to restrain and forbid, as witness the multitude of laws, boards, commissions, decisions and rulings that have grown up—all restrictive. "Thou shalt not" is the burden of most administrative legislation and office rulings.

The effect is delay, added expense, discouragement of men, and unsatisfactory service at every step, for after engaging the best available men, administration proceeds to tie their hands and to exploit their funds.

EFFECTS OF ADMINISTRATION ON MEN

The effect of too much administration upon the scientific worker is at first one of disappointment, then of discouragement, and finally of disgust. Conditions as they are now developing not only constitute an unhealthy example for our young men in college, but they are deterring thoughtful men from entering the public service. Real men are unwilling to subject themselves to unnecessary restriction and petty annoyances, the obvious exploitation of funds and the artificial multiplication of administrative positions, with their overhead charges upon research and their power to bring reproach upon the best intentions and the most faithful service. There is danger to everybody when the crash comes, as it will come when the public begins to understand the foreign forces that have attached themselves to the serious business of research in agriculture.

But it is objected that without supervision much time and money are wasted; besides some men are lazy. Granted without argument! As to waste of time and money, some of both is inevitable. Many excursions were made northward before the pole was conquered. Perhaps some money, even lives, were wasted, but not the attempt as a whole. At the most no scheme could be invented that so inevitably leads to time service and fraud as the one now building up around our institutions where the public is made to feel that nobody is either honest or capable save the "inspector" and the appointed overlord who gets his commission by executive appointment and reports to nobody. What guarantee have we of his honesty?

Modern efficiency standards are developed from the manufacture of shoes, clothes-pins, overalls, etc., and are expressed in motions per hour. These standards are not applicable to research. Money put into research is bread cast upon the waters. In the serious business of searching after new truth, no man knows in advance the road

that shall be traveled before he may stand upon the heights. He may be held down, but he can not be pushed up. No power on earth is so impelling as his own initiative and determination to achieve.

Under what project did Darwin work? Did Faraday report regularly upon the progress of his mental wanderings after firm resting places? Could the searchers after the principle of radioactivity report progress from time to time? How shall we, even in the interest of efficiency, record the Sermon on the Mount or the Gettysburg address in terms of laboratory hours? Go to, we are dealing with strange gods at this point. Let us be forgiven and return to the worship of the true Deity which is ready to recognize the individual as the source of all real discovery and which is willing to accredit him with as much of honesty of purpose, and of faithfulness to the public as the political appointee, also an hireling. Above all let us not set up to rule over us machinery that is manned by those individuals who could not themselves do the work they attempt to supervise. And above all I protest against the present temper of the public mind which has been tampered with by professional exploiters until it is unwilling to trust its business in the hands of boards or other deliberative bodies even when composed of reputable citizens busy for the most part about their own affairs, but overrules their judgment by exalting individuals who have no occupation of their own but whose profession it is to multiply and to fill administrative positions, that render no service but that hinder mightily the progress of the true scientist whose one occupation is research.

Here have come together the working scientist and the professional officeholder. They face in opposite directions. At present the office man has the upper hand. He assumes the rôle of critic and the public has accorded him all he asks. The time will come, however, and may it not be long delayed, when the scientist will again come into his own and the institution to which he belongs will recognize no overlord, except the auditor, who will be an auditor, not an autocrat in technical science.

THE RANGE

So thoroughly has chemistry taken the lead as a science fundamental to all improvement in agriculture that the terms are sometimes used synonymously. However, the outlook for the development of other sciences in their relation to agriculture is extremely suggestive. Physics, for example, has never consciously served farming. I know of but two graduate students in agriculture who have specialized in physics, and it was the experience of both that physicists were somewhat surprised to learn that their science could be of the slightest use in agriculture, whereas the facts are, it is of fundamental importance at many points.

Both botany and zoology possess undeveloped opportunities little dreamed of. They have in the past served agriculture mainly in the field of genetics or of animal and plant diseases. We are only beginning to study crop production from the standpoint of the physiology of the plant, its sensitive periods and the conditions essential to successful growth.

As a whole we have only scratched the surface of science in its relation to the practise of farming. The outlook is nothing short of a panorama to him who has an adequate vision of the future and the ability to work in any one of the great fields of science, distinguishing clearly between science *per se* and its application to the arts of man.

The writer is not pessimistic and is in no sense discouraged with the outlook. He is

concerned only with matters as they stand. Some of the conditions of which we complain are accidental and deplored as much by the administrative officers who happen to be in charge as by the scientific workers in the laboratories. Others are the result of a more or less wholesale desire to exploit a situation which enjoys large appropriations of public funds. This is the element that must be sloughed off at all cost.

The public who is to be served and who pays the bills will ultimately clean the stables, if only the scientists and the institutions who have permanent reputations to defend and who outlive successive generations of appointed overseers will be true to their responsibilities and insist upon working conditions favorable to reasonable results.

No other branch of science is so richly endowed as is agriculture; no other promises such important results; no other has so large an army of men faithful to their duties; no other so enjoys the confidence of the public. The question is, shall agricultural science with all these advantages weighed against the disadvantages be stronger or weaker than other branches of study, and can the publicly supported institutions with superior revenues afford equal advantages for research as compared with independent institutions resting upon private funds?

E. DAVENPORT

UNIVERSITY OF ILLINOIS

SCIENTIFIC EVENTS

SIGMA XI IN DULUTH, MINN.

THE "Quarter Century Record and History" of Sigma Xi appeared in 1913. It contained, among other valuable information, the names and addresses of all those elected to Sigma Xi up to December 31, 1911. Mr. Eugene Van Cleef conceived the idea of organizing the members residing in Duluth, believing that such an organization could prove more or less successful. As a result of a little correspondence and personal interviews "The Society of Sigma Xi of Duluth, Minn.," was consummated with 10 charter members in July, 1913.

Meetings are held bimonthly. A dinner is served after which an informal paper is presented by one of the members and discussed by all. The wives of the members and a lady friend of each of the unmarried members may be guests at any meeting. Their attendance has been almost as regular as that of the men.

Each paper has covered some phase of the work in which the respective members are engaged. The nature of these presentations may be gained from some of the following titles selected at random: Heredity and Environment; The Valuation of Public Utilities; Design and Construction of the Aerial Bridge at Duluth; Climate and Man; The Learning Process and Acquisition of Skill, etc.

At present the membership consists of 3 mechanical engineers, 1 civil engineer, 1 agriculturist, 1 geographer, 1 physician and 1 psychologist. With such a variety of interests represented each one is assured of receiving information worth while at each meeting. The discussions are thoroughly alive and stimulating.

That the meetings have been worth much to each one is attested by the fact that the attendance for the past four years has been almost perfect, no one being absent unless because of circumstances over which they have had no control.

This announcement is made to the readers of SCIENCE, in the belief that others may care to adopt the idea in the locality in which they are now residing. There seems to be no reason for the cessation of interest in the welfare of Sigma Xi just because one is not engaged in academic work. The spirit of research should live after college days among all members of Sigma Xi, regardless of the course in life which they may pursue. Details of the organization in Duluth, not cited above, will be gladly given to any who may apply to the undersigned.

EUGENE VAN CLEEF

STATE NORMAL SCHOOL,
DULUTH, MINN.

THE HANCOCK MINERAL COLLECTION

As somewhat exaggerated accounts of this collection appeared in the newspapers at the time of its purchase for the Harvard Mineralogical Museum a brief description is opportune.

Elwood P. Hancock who died last December in Burlington, N. J., in his eighty-second year, was a landscape artist by profession and also carved in wood as a pastime; he began to collect minerals when nineteen years old and continued throughout his life. To this pursuit he brought the artist's eye and skilled manipulation with fine tools as well as a wonderful "flair" for fine specimens even when the crystals were buried in the matrix, and acquired a keen acquaintance with minerals. For many years he visited Franklin Furnace twice yearly, and made trips to Paterson, Nova Scotia, Virginia, North Carolina and other famous American mineral localities, and the choice specimens he brought back were worked out with incredible skill to show their beauty, with hardly a suspicion that tools had been used to clear away the matrix.

The collection contains about 1,600 specimens of generally the first quality, usually matrix specimens showing good crystals. The standard European and other non-American localities are fairly represented with excellent and well-chosen material but the greater interest is in the superb crystals from American localities such as Franklin Furnace, Tilly Foster mine, Amelia Court House, Va., and others where Mr. Hancock collected on the spot and then worked out his material with incredible skill and patience.

JOHN E. WOLFF

HARVARD UNIVERSITY

AMERICAN ACADEMY OF PUBLIC HEALTH

THE organization of this society, which was formed at a meeting held in Cincinnati, October 23, 1916, has been noted in SCIENCE. The *New York Medical Journal* states that a constitution was adopted stating that the objects of the new organization are to increase the efficiency of its members through the discussion of public health problems, to promote the efficiency of public health administration, to raise the standards of public health practise, and to stimulate original work in public health science. Qualifications for membership are based upon achievements as public health workers and scholarship in public health science. There are two classes of members: Active members, who must be, at the time of election, not less than thirty years of age and actively engaged in public health work, and honorary members who are chosen in recognition of unusual ability or length of service in public health work. When the membership has reached fifty, not more than five new members shall be added in any one year, in addition to filling vacancies. At the meetings of the organization it is not proposed to read scientific papers, but to devote the time to the open discussion of the reports of committees. During the year the various commitees will be called upon to prepare reports on such public health problems as are suggested by the membership, and their reports will be placed in the hands of the members several weeks in advance of the annual meeting so that the members may come to the meetings prepared to discuss the same intelligently. It is planned to publish from time to time the opinions which the membership of this academy may reach as the result of their deliberations on the problems presented to them. The members of the organization for the first year are: Dr. Carl L. Alsberg, Dr. John F. Anderson, Dr. Hermann M. Biggs, Dr. Rupert Blue, Dr. Charles V. Chapin, Dr. H. W. Conn, Dr. Haven Emerson, Dr. W. A. Evans, Dr. Irving Fisher, Dr. Lee K. Frankel, Dr. Allen W. Freeman, Dr. Wade H. Frost, Dr. George W. Fuller, Dr. John S. Fulton, Dr. Joseph Goldberger, Dr. S. S. Goldwater, Dr. William C. Gorgas, Dr. Selskar M. Gunn, Dr. Frederick L. Hoffman, Dr. J. N. Hurty, Dr. E. O. Jordan, Dr. J. W. Kerr, Dr. J. J. Kinyoun, Dr. J. H. Landis, Dr. E. C. Levy, Dr. L. L. Lumsden, Dr. G. W. McCoy, Dr. A. J. McLaughlin, Dr. Joseph S. Neff, Dr. Charles E. North, Dr. William H. Park, Dr. Earle B. Phelps, Dr. W. S. Rankin, Dr. M. P. Ravenel, Dr. M. J. Rosenau, Dr. William T. Sedgwick, Dr. W. F. Snow, Dr. C. W. Stiles,

Dr. J. W. Trask, Dr. Victor C. Vaughan, Dr. William H. Welch, Dr. George C. Whipple, Dr. C.-E. A. Winslow, Dr. William C. Woodward.

SCIENTIFIC NOTES AND NEWS

Professor R. A. Cooley, state entomologist and professor of zoology at the Montana State College, has been elected president of the American Association of Economic Entomologists.

At the annual meeting of the Society of American Bacteriologists officers were elected as follows: *President,* Professor L. F. Rettger, of the Sheffield Scientific School; *Vice-president,* Dr. R. E. Buchanan, Iowa State College; *Secretary and Treasurer,* Dr. A. Parker Hutchins, Glenolden; *Delegate* to council of the American Association for the Advancement of Science, Dr. P. F. Hadley, Kingston, R. I.; *council members,* Miss Jean Broadhurst, New York; Dr. P. F. Clark, Wisconsin; Dr. L. A. Rogers, Washington, D. C., and A. E. Ingham, Boston.

Professor W. F. M. Goss, dean of the college of engineering of the University of Illinois, has resigned to accept the presidency of the Railway Car Manufacturers' Association of New York. The resignation will take effect as soon as Dr. Goss can be relieved.

General George W. Goethals, recently chief engineer of the Panama Canal and governor of the Canal Zone, has announced the opening of consulting engineering offices in New York City. General Goethals has associated with him specialists, including George M. Wells, former resident engineer in charge of building construction, Canal Zone, and will engage in a general consulting practise in civil, electrical, mechanical and hydraulic engineering.

In memory of Judge Harvey H. Baker, of the Boston Juvenile Court, there has been established a Judge Baker Foundation. Dr. William Healy, director of the Psychopathic Institute of the Juvenile Court of Cook County, will have charge of the work of the new foundation.

The Delalande-Guérineau prize of the Paris Academy of Sciences has been awarded to Sir Ernest Shackleton, for his explorations in the Antarctic continent.

The Boyle medal of the Royal Dublin Society has been conferred on Professor Henry H. Dixon, professor of botany in the University of Dublin.

At a stated meeting of the New York Academy of Medicine on February 1, Dr. Walter B. James announced that the portrait of Dr. William M. Polk had been presented to the academy, and that this completed the full line of portraits of presidents of the academy. Dr. George D. Stewart made the address of acceptance on behalf of the academy. The portrait is the work of Miss Belle Isaacs.

The twelfth annual banquet of the Cornell Society of Civil Engineers at the Hotel Breslin, New York, on January 19, was given in honor of Professor Irving Porter Church. Nearly a hundred and fifty engineers were present.

Before leaving the United States to spend a year in the far east, Dr. Liberty Hyde Bailey was the guest at a dinner given by the members of the Ithaca Board of Commerce and his fellow members of the Cornell faculty. Roger B. Williams, trustee of the university, was toastmaster. The speakers were Dr. W. H. Jordan, head of the State Experimental Station at Geneva; Dean A. W. Smith, of the College of Mechanical Engineering; Dean A. R. Mann, of the College of Agriculture; Dean C. A. Martin, of the College of Architecture; Dean E. H. Haskell, of the College of Civil Engineering; Professor Nathaniel Schmidt, of the department of Semitics, and Jacob Rothschild, chairman of the Board of Commerce.

Dr. Gregory D. Walcott, professor of philosophy and psychology in Hamline University, has been given a year's leave of absence to teach psychology and logic in the government college of Tsing Hua, China. He expects to sail from San Francisco about the first of next July and to be abroad until September, 1918.

DR. R. SAUNDBY has been appointed by the Royal College of Physicians, London, Harveian Orator; Dr. E. S. Reynolds to be Bradshaw Lecturer for this year, and Dr. T. M. Legge to be Milroy Lecturer for 1918.

AT the Royal Institution Professor C. S. Sherrington is giving a course of six lectures on "The Old Brain and the New Brain, and their Meaning," and Mr. A. R. Hinks, F.R.S., two lectures, on "The Lakes and Mountains of Central Africa."

RUDOLF VON VIRCHOW'S family have donated to the Berlin "Goldsammelstelle" seven gold medals that had been conferred on Virchow by foreign scientific organizations. The medals have a total weight of 1,200 gm. and are valued at about $650. The heirs of Mommsen have taken a similar step, turning in to the gold reserve the medals that had been awarded to Mommsen in his day.

THE Chemical Society of France held a memorial meeting, on December 9, on the hundredth anniversary of the birth of the French chemist, C. F. Gerhardt, 1816–1856, known for his work on the structure of the molecule.

MR. ANDREA ANGEL, chief chemist at the factory at Woolwich where the recent explosion occurred, the story of whose self-sacrifice is told in the official report of the disaster, was born in 1877. Educated at Christ Church, Oxford, he was lecturer in natural science at Brasenose and also hon. tutor in chemistry to the non-collegiate students.

PROFESSOR E. GAUPP, professor of anatomy in Breslau, died on November 24, 1916.

THE death is announced of the former professor of ophthalmology at the Universities of Bern and Rostock, Dr. von Zehender, aged ninety-one years.

IN preparation for the next annual meeting of the American Medical Association, which is to be held in New York during the week of June 4–10, a large committee of local physicians has been formed charged with perfecting the details necessary to make such a meeting a success. Dr. Wendell C. Phillips is chairman, Dr. Alexander Lambert is treasurer and Dr. Floyd M. Crandall is secretary of the New York Committee of Arrangements. The headquarters of the committee are in the Academy of Medicine, 17 West 43d Street. Subcommittees have been formed dealing with finance, registration, entertainment, hotels, sections, scientific exhibit, commercial exhibit, press and publicity, and golf. On the two days preceding the meeting, namely, on June 4 and 5, there will be a clinical congress, during which clinics, demonstrations and tours of inspection will be conducted in hospitals, laboratories, clinics and scientific institutions throughout the city. The organization of the features to be made available at this time has been entrusted to over thirty different sections, representing general medicine, pharmacology and therapeutics, pathology and physiology, preventive medicine and hygiene, pediatrics, dermatology, neurology, mental diseases, general surgery, orthopedic surgery, gynecology, obstetrics, urology, rectum and colon, ophthalmology, otology, rhinology and laryngology, stomatology, roentgenology, anesthetics, and women physicians. In addition to this, there are sections dealing with allied topics, such as trained nursing and training schools, district nursing, hospital social service, planning and financing of municipal and non-municipal hospitals, hospital superintendents and executives, and military surgery and Red Cross.

A BILL prepared by the California state board of health carrying with it an appropriation of $500,000 provides for the establishment of a state psychopathic hospital to be located near the University of California Medical School in San Francisco, to be governed by the university regents with the professor of psychiatry as ex-officio director. The hospital is to provide not only a research laboratory but treatment for all patients requiring special or intensive study for a short period.

A NUMBER of members of the Kaiser Wilhelm Association have planned a German institute for research on psychiatry. The funds subscribed as yet do not permit an independent establishment, but it is proposed to organize an institute of the kind as a branch of the Munich psychiatric clinic.

THE governor of Minnesota has recommended to the legislature that $25,000 be appropriated at the present session for the use of the state entomologist in combating white pine blister rust in Minnesota. As arranged, the plant pathologist of the experiment station and the state entomologist will work in cooperation the coming season; the plant pathologist to have charge of scouting and eradication along the eastern border of Minnesota in the St. Croix Valley; the state entomologist, by virtue of his office as nursery inspector, will take care of inspection and eradication in nurseries, parks, cemeteries and private plantings. It is expected that the state of Wisconsin will cooperate energetically on its side of the St. Croix River.

UNIVERSITY AND EDUCATIONAL NEWS

THROUGH the generosity of a friend of Harvard University, who prefers to remain unknown, there has been established an assistant professorship of bacteriology in the Harvard Medical School, to be known as the Silas Arnold Houghton Professorship. In the words of the donor, the gift is made "in grateful memory of Dr. Houghton as a physician and a friend."

M. G. KAINS, professor of horticulture and horticulturist at the Pennsylvania College and Station, has resigned and has been succeeded by Dr. S. W. Fletcher, formerly director of the Virginia Station.

DR. H. B. FANTHAM, of Christ's College, Cambridge, has been appointed to the professorship of zoology at the South African School of Mines and Technology, Johannesburg, and Dr. C. E. Moss, of Emmanuel College, has been appointed professor of botany to the same institution.

AT London University Mr. James John Guest, B.A., of Trinity College, Cambridge, has been appointed to the university readership in graphics and structural engineering, tenable at University College, in succession to Dr. W. H. Eccles, reader in graphics, who has been appointed professor of applied physics and electrical engineering at Finsbury Technical College.

DISCUSSION AND CORRESPONDENCE

THE SLIDES OF THE PANAMA CANAL

TO THE EDITOR OF SCIENCE: In view of the fact that portions of the annual report of the governor of the Panama Canal for the fiscal year ending June 30, 1916, containing criticisms of the writer's views of the canal slides have been published recently in many newspapers throughout the country, the writer is impelled to make the following statement.

The governor implies in his report that the sole basis for the writer's expressed opinion that "practically all of Gold Hill and much of Zion Hill must be removed" "before the Canal can be said to be completed and permanently opened to traffic" was, as he states, an investigation of "fully three or four hours" and says that he (the writer) stated that he had made a "thorough examination." In the first place, the writer did not state that he had made a "thorough examination," these words being used without the writer's knowledge. Whether the examination was sufficiently thorough and enough information obtained to justify an expression of opinion may be determined from the following statements.

It is doubtful whether any other activity of the government has ever received equal publicity through the press, official reports, lectures and descriptions of returned visitors and employees as has the Panama Canal during its construction, so that there has been no excuse for any interested person not having exact and detailed information concerning the canal project.

The writer, as well as most geologists, had his interest aroused several years ago, by the unexpected difficulties encountered by the Panama Canal engineers. This was especially the case because it was evident that the combination of geological and climatic conditions prevailing there were mainly responsible for the troubles. From careful studies of much published and unpublished data the writer was fairly familiar with the situation long before the opportunity came to visit the region.

On returning from an extensive trip through the South American continent, the writer

spent October 22, 23, and November 1–4, 1915, in the Canal Zone and the intervening time, October 24–31, in Costa Rica. During the period heavy downpours of rain were frequent in both Panama and Costa Rica and landslides were especially active. Numerous landslides were observed in Costa Rica. While there, also, opportunity was afforded in the Aguacate gold mines to observe the great depth to which oxidation and rock decomposition extends in a region where the climatic conditions are similar to those prevailing in Panama.

On returning to Panama a landslide was seen along the line of the Panama Railroad which interfered with traffic for a short time. The forenoon and early part of the afternoon of November 2 were spent in going over the entire area then in movement on both sides of the Gaillard Cut and also a trip across the Cucaracha slide and entirely around Gold Hill. The area affected by the slides is 0.88 mile in length along the canal and extends back 1,400 feet on the east side of the canal and 1,200 feet on the west, a large part of which was then in actual movement. In the afternoon, through the courtesy of the Canal Commission officials, some time was spent in the examination of unpublished cross sections of the cut made during the process of steam-shovel excavation.

The information obtained seemed sufficient on which to base an opinion and forced the conclusion upon the writer that the slide conditions were more serious than commonly supposed and influenced him in giving expression to his views. Subsequent movements seemed to prove that the seriousness of the situation had not been generally appreciated.

In the governor's report it is stated that "probably the greatest injury done the Canal was through Benjamin Le Roy Miller, Ph.D., who occupies the chair of geology in Lehigh University." The writer can not accept such responsibility and believes that the "greatest injury done the Canal" has been the frequent disappointments to the shipping public, due in part to the closing of the canal and the uncertainty regarding its use, but in a large measure to the over-optimistic reports emanating from the Canal Zone that the slides would shortly cease and permanent service be established by the clearing of the channel. It should be recalled that the canal was closed to traffic for over 4½ months after the writer's conclusions were published, although the shipping public was led to believe that service would be re-established and maintained with comparatively little delay. As stated in the governor's report the canal was closed 232 days, between the date of opening, August 15, 1914, and June 18, 1916, slightly more than one third the time. These facts undoubtedly furnish other and more weighty reasons for the shipping public's loss of confidence in the present usefulness of the canal than the expression of opinion of a visiting geologist.

The writer agrees with Dr. J. C. Branner, president emeritus of Stanford University, who was a member of the Committee of the National Academy of Sciences that went to Panama last December at the request of President Wilson to study the slides and prepare a report upon them, in statements which he made in *Sunset, the Pacific Monthly*, for June, 1916. He says:

> But when one sees the sliding area extending further and further away from the Canal, the volume of the moving masses gradually getting bigger and bigger, and the very hills themselves toppling over and adding to the confusion trees, mud, rocks and great blocks of basalt as big as houses, and when he sees that these millions of tons, that have to be removed, cost about sixty cents a cubic yard, he feels that some way ought to be found to make the hills stay where they are.

How shall the hills be made to "stay where they are" is the question? Dr. Branner as the result of "forty years of study of landslides in tropical countries" believes that this can only be effected by preventing the heavy rainfall of the region from entering the ground adjacent to the canal. It is somewhat questionable whether this can be accomplished and, if not, there seems no alternative but the complete removal of the threatening hills. Perhaps some unnecessary material might be removed but this would be fully compensated for by the increased confidence in the canal. One writer states:

It may be accepted as a fact that, unless dredging is supplemented by preventive measures, slides will continue to fill the Canal prism at intervals for an indefinite period, that traffic through the Canal will be interrupted for weeks and months at a time and that the expense of removing the slide material will add millions to the investment. As a commercial undertaking the Canal will be a flat failure unless continuous traffic through the waterway can be guaranteed; if extensive delays due to slides occur every fall when the effect of the summer deluge is felt, schedules, rates and contracts will be disturbed so frequently that fifty per cent. of the Canal's usefulness will be gone, even if the closed season lasts for only a few weeks at a time.

Aside from its commercial aspect, the Panama Canal was designed to be one of the country's most important defensive works. A continuation of the slides at frequent intervals will render the ditch worthless as a defense measure. . . .

Half a canal is worse than no canal. Muffled exclamations of admiration will not stop the slides. Unless the slides are stopped, definitely and permanently, the Canal is a failure as a commercial undertaking and a defense measure. Dredging the débris will not stop the slides.[1]

Neither Dr. Branner, the writer, nor any other patriotic citizen would intentionally circulate false reports in regard to existing conditions in the Panama Canal region nor venture to make predictions that might unduly alarm the public, but, on the other hand, nothing is gained by fostering a false sense of security.

In England, Germany and Russia reports of the failure of the canal are said to have been freely circulated. These reports have emanated from geologists and engineers and seem to have led many of the people in those countries to believe that the Panama Canal would eventually be abandoned and the Nicaragua route substituted. These reports either exaggerate the importance of the slides or underestimate the will of the people of this country. If the earthquake menace, to which Dr. Branner calls attention in his article in *Sunset,* does not materialize, the Panama Canal will unquestionably be completed and made to serve its intended purpose, even though it require years of time and the expenditure of additional millions of dollars to accomplish. The American people would not willingly abandon a project that has so stirred the pride and stimulated the patriotism of the entire country as has the Panama Canal, even though the length of time for its completion and its cost far exceed the early calculations.

BENJ. L. MILLER

LEHIGH UNIVERSITY,
December 12, 1916

[1] Editorial in *Sunset, the Pacific Monthly,* June, 1916, p. 35.

SCIENTIFIC BOOKS

Field Geology. By FREDERICK H. LAHEE, Assistant Professor of Geology in the Massachusetts Institute of Technology. McGraw Hill Book Co., 1916.

The title of this book suggests two possible ways in which it may be used; as a preparation for field work, and a hand-book in the field. It is for the latter use, as a reference book in the field, that it will be found to be especially valuable.

The plan of the author is an unusual and, in the reviewer's opinion, a very desirable one. "Where possible the treatment has been empirical rather than genetic." Two examples will illustrate this method of presentation. Under Hills, Ridges and Other Positive Land Forms are included (1) Fault Mountains, (2) Volcanic Cones, (3) Constructional Hills and Ridges, such as sand dunes, drumlins, eskers, kames, moraines and winter talus ridges. Under Cross-bedding are included (1) Delta Structure, (2) Torrential Cross-bedding, (3) Wave-built Cross-bedding, (4) Eolian Cross-bedding, and (5) Ripple marks. In other words, forms which look alike are classed together without regard to their origin.

A number of tables for the identification of structures and topographic forms are scattered through the text and included in the appendix. These analyses have been prepared with almost as much care and detail as are those in botanies for the identification of flowering plants. Especially is this true of the table of clastic sedimentary rocks (pp. 463–471). It is doubtful, however, if these tables will prove of great value in the field as

they are academic rather than practical. They will probably confuse the elementary student and will not be of great help to the advanced student. This painstaking analysis of the subject, however, has resulted in an admirable selection of material and an unusually logical presentation.

Mention should be made of the excellent block diagrams, of which there are more than 100, and of the numerous sections. Many of these drawings are new and are of great value, especially in the presentation of structural geology.

The typographical mistakes and occasional slight errors in statement which seem impossible to eliminate in a first edition will, doubtless, be absent in the second printing. Many who use the book will regret that a fuller discussion of the plane table is not given.

The limp covers, small size and light weight make this a convenient volume to carry about in the field, and both students who have only an elementary knowledge of geology and seasoned geologists will find the book a useful field companion.

Herdman F. Cleland
Williams College,
Williamstown, Mass.

The Endocrine Organs. By E. A. Shäfer. Longmans, Green and Company. London, 1916. Pp. 156.

The author has endeavored to compress into this book a great number of observations concerning the organs of internal secretion. He has not published a bibliography, this task having been recently performed by Biedl and by Vincent. As each of the organs is taken up the facts of its embryology and structure are briefly presented. Then we have an account of the properties of the extract and of the conditions produced by excessive and deficient activity, ablation furnishing the limiting case. There are well-chosen plates and tracings to the number of 104.

The attempt to read the chapters consecutively results in an oppressive realization of the magnitude of the subject. During the last few years emphasis has been increasingly upon the reciprocal relations of the several organs. As each may reinforce, oppose, or otherwise modify the influence of every other, we have here a number of possibilities which increases according to the principle of permutations and combinations. The writer of the book has not neglected this aspect of the matter, but has wisely restricted his discussion to the more striking instances. His condensed account of the work of hormones and chalones (excitants and inhibitors) in the animal economy will give any reader a wide, preliminary view of a field the importance of which we are but just coming to appreciate.

P. G. Stiles

RACE HYGIENE IN NORWAY

The Norwegian government under the lead of Professor Jon Alfred Mjöen, of Christiania, well known for his researches in race hygiene, and on the direct effect of alcohol on the integrity of germ cells, has under way a program of Applied Race Hygiene. As planned by Professor Mjöen this will involve:

A. Negative Race Hygiene

Segregation, optional for feeble-minded, epileptics and other individuals physically or mentally crippled, *obligatory* for drunkards, habitual criminals and professional beggars and all who refuse to work.

Sterilization.—Professor Mjöen is opposed to compulsory sterilization. But for certain types of crime, there is earnest need of considering methods of treatment more effective than those now in use.

B. Positive Race Hygiene

Biological Enlightenment.—The study of race biology in school and university. The development of an institute for genealogical research. A state laboratory of race hygiene.

Decentralization.—Colonization from congested districts.

A *regressive tax* and *progressive* wage system in certain conditions.

Maternity Insurance and other protective measures for the welfare of the infant.

C. PROPHYLACTIC RACE HYGIENE

Abatement of Racial Poisons, lead compounds, narcotics, syphilis and especially the use of alcohol.

Progressive Taxation of alcoholic liquors.

Treatment as a state function, of all maladies injurious to the race (alcoholism, plumbism, narcotism, syphilis, gonorrhea).

Health Declaration as a requisite to marriage.

Of these maternity insurance and the last three items have been already put into operation by the government.

Under the title of "Race hygiene," Dr. Mjöen has lately published, in Norwegian, an important work setting forth the scientific reasons for each of the lines of action proposed.

DAVID STARR JORDAN

A CENSUS OF THE PERIODICAL LITERATURE OF CHEMISTRY PUBLISHED IN THE UNITED STATES

DURING recent years there has been a rapid increase in chemical research in the United States. The statistics given in the following tables have been compiled to secure a rough estimate of this increase. In examining the tables it should be remembered that they are of value only in giving a statistical measure of the growth of chemical research and that the details are liable to be misleading. It sometimes happens that a single paper covering a few pages is of far greater value than dozens of other papers which may cover hundreds of pages.

In the tables only original papers have been considered and papers of less than one page were not included. One page of the *Journal of Industrial and Engineering Chemistry* has been counted as equal to three pages of the other journals. The journals selected for comparison are:

American Chemical Journal,
Journal of the American Chemical Society,
Journal of Physical Chemistry,
Journal of Biological Chemistry,
Journal of Industrial and Engineering Chemistry.

In preparing the data all articles were listed on cards and the cards grouped in different ways to prepare the successive tables.

TABLE I

Total Number of Articles and Pages in Each Journal

Years	*Am. Ch. J.*		*J. A. C. S.*		*J. Phys. C.*		*J. Biol. C.*		*J. I. E. C.*		Totals	
	Articles	Pages	Articles	Pages	Articles	Pages	Articles	Pages	Articles	Pages	Articles	Pages
1909–10	88	1,704	338	2,658	62	1,429	133	1,519	175	1,915	796	9,225
1914–15	....	....	542	5,003	81	1,388	402	3,810	390	3,423	1,415	13,624

Gain

	Articles	Pages	Articles, Per Cent.	Pages, Per Cent.
Journal of Biological Chemistry	269	2,291	202	150
Journal of Industrial and Engineering Chemistry	218	1,508	124	78
Journal of the American Chemical Society	204	2,345	60	88
Journal of Physical Chemistry	19	—41	30	—2
Total	707	6,103	77	66

TABLE II

Distribution among Classes of Institutions

	1909–10		1914–15	
	Articles	Pages	Articles	Pages
A. General Scientific:				
Educational	597	7,235	902	9,165
Charitable	4	41	21	197
Research	43	443	133	1,277
B. Commercial Scientific:				
General	52	528	98	675
Analytical	4	53	1	6
Research	6	97	7	57
C. Government Bureaus, Experiment Stations, etc.	93	827	253	2,247
	796	9,225	1,415	13,624

TABLE III

Institutions which published Five or More Articles during the Four Years

	1909–10		1914–15	
	Articles	Pages	Articles	Pages
Arizona, University of	5	29	None	None
Armour and Company	None	None	5	20
Bryn Mawr College	7	119	4	61
Calcutta, India, Presidency College	None	None	18	107
California University	19	256	39	403
Carnegie Institution of Washington	8	131	19	281
Chicago, University of	36	430	16	234
Cincinnati, University of	1	5	9	126
Clark University	5	50	8	84
Columbia University	28	226	29	444
Columbia University and Roosevelt Hospital	None	None	6	75
Connecticut Agricultural Experiment Station (N. H.) and Yale University	None	None	10	144
Cornell University	32	1013	59	955
Cornell University, Medical College	7	73	20	261
Dodge and Olcott Company	None	None	5	29
General Electric Company	4	42	7	114
Hackney Technical Institute	6	35	None	None
Harvard University	31	396	61	652
Harvard University, Medical School	15	73	13	73
Harvard University, Medical School and Massachusetts General Hospital	None	None	9	61
Hawaii Agricultural Experiment Station	2	25	4	27
Herter Laboratory	19	153	7	51
Illinois, University of	45	504	33	281
Illinois, University of, and Jefferson Medical College	None	None	7	51
Iowa State College	None	None	17	122
Iowa, University of	4	21	8	105
Johns Hopkins University	33	825	28	349
Kansas Agricultural College	None	None	8	17
Kansas, University of	3	17	8	125
Kentucky, University of	3	9	8	52
Leland Stanford Junior University	3	23	7	104
Little, A. D., Company Laboratory	5	81	2	27
McGill University	4	31	7	49
McMaster University	6	56	None	None
Massachusetts Agricultural College (including station)	None	None	10	119
Massachusetts General Hospital	1	7	5	45
Massachusetts Institute of Technology	35	494	4	37
Mellon Institute	None	None	18	174
Michigan Agricultural College	1	13	5	31
Michigan, University of	8	123	17	189
Minnesota, University of	7	40	24	231
Missouri, University of	12	119	12	78
Montefiore Home and Hospital for Chronic Invalids	None	None	6	69
Morris and Company	3	13	3	10
Nebraska, University of	7	59	2	26
Nevada, University of	3	5	3	31
New Hampshire College	9	39	12	66
New York, College of the City of	4	20	6	44
New York (City) College of Physicians and Surgeons	4	61	1	9
New York (City) Postgraduate Medical School and Hospital	None	None	8	53
New York (City) University	5	44	None	None
New York (City) Testing Laboratories	3	31	5	35
New York (State) Agricultural Experiment Station	2	13	11	97
North Carolina, University of	11	117	5	29
Northwestern University	2	10	4	45
Northwestern University Medical School	None	None	6	65
Ohio Agricultural Experiment Station	4	27	3	34
Ohio, University of	5	36	7	83
Oregon Agricultural Experiment Station	4	31	5	30
Parke, Davis and Company	2	61	9	43
Pennsylvania State College	5	57	3	22

TABLE III—*Continued*

	1909–10		1914–15	
	Articles	Pages	Articles	Pages
Pennsylvania, University of	11	51	34	225
Philadelphia Polyclinic and College for Graduates in Medicine	None	None	5	40
Princeton University	7	56	10	77
Purdue University	1	5	6	21
Rockefeller Institute	10	143	54	431
Roosevelt Hospital, N. Y.	2	3	19	171
Rush Medical College	None	None	5	44
Tennessee, University of	3	18	6	40
Texas Agricultural Experiment Station	3	10	4	15
Texas, University of	4	81	4	39
Toronto University	8	167	7	53
U. S. Agriculture, Department of, and Missouri, University of	None	None	6	72
U. S. Animal Industry, Bureau of	None	None	5	51
U. S. Chemistry, Bureau of	24	209	29	173
U. S. Forest Products Laboratory	None	None	17	130
U. S. Geological Survey	4	27	6	41
U. S. Hygienic Laboratory	7	39	3	19
U. S. Mines, Bureau of	None	None	37	399
U. S. Mint, Bureau of	2	15	3	51
U. S. Plant Industry, Bureau of	None	None	9	63
U. S. Soils, Bureau of	14	198	21	154
U. S. Standards, Bureau of	2	7	13	111
Utah, University of	8	80	None	None
Washington State College	3	15	2	15
Washington, University of	5	29	17	134
Washington University, St. Louis	1	3	13	145
Wesleyan University	7	54	2	11
Western Reserve University	3	20	5	68
Wisconsin, University of	24	301	40	513
Yale University	39	413	61	532

TABLE IV

Institutions Which Published Ten or More Articles During 1909–10 Arranged in Order of the Number of Articles

	Articles	Pages
Illinois, University of	45	504
Yale University	39	413
Chicago, University of	36	430
Massachusetts Institute of Technology	35	494
Johns Hopkins University	33	825
Cornell University	32	1,013
Harvard University	31	396
Columbia University	28	226
U. S. Chemistry, Bureau of	24	209
Wisconsin, University of	24	301
California, University of	19	256
Herter Laboratory	19	153
Harvard University, Medical School	15	73
U. S. Soils, Bureau of	14	198
Missouri, University of	12	119
North Carolina, University of	11	117
Pennsylvania, University of	11	51

TABLE V

Institutions Which Published Ten or More Articles During 1914–15, Arranged in Order of the Number of Articles

	1914–15	
	Articles	Pages
Harvard University	61	652
Yale University	61	532
Cornell University	59	955
Rockefeller Institute	54	431
Wisconsin, University of	40	513
California, University of	39	403
U. S. Mines, Bureau of	37	399
Pennsylvania, University of	34	225
Illinois, University of	33	281
Columbia University	29	444
U. S. Chemistry, Bureau of	29	173
Johns Hopkins University	28	349
Minnesota, University of	24	231
U. S. Soils, Bureau of	21	154
Cornell University, Medical College	20	261
Carnegie Institution of Washington	19	281
Roosevelt Hospital, N. Y.	19	171
Calcutta, India, Presidency College	18	107
Mellon Institute	18	174
Iowa State College	17	122
Michigan, University of	17	189
U. S. Forest Products, Laboratory of	17	130

Washington (State), University of.	17	134
Chicago, University of	16	234
Harvard University, Medical School.	13	73
U. S. Standards, Bureau of	13	111
Washington University, St. Louis..	13	145
Missouri, University of	12	78
New Hampshire College	12	66
New York Agricultural Experiment Station, Geneva	11	97
Connecticut Agricultural Experiment Station and Yale University	10	144
Massachusetts Agricultural College	10	119
Princeton University	10	77

TABLE VI

Institutions represented in 1909–10, only....	76
Institutions represented in 1914–15, only....	198
Institutions represented in both periods......	94
Total	368

Of the 198 new contributors in the second period, 89 appear in the *Journal of Industrial and Engineering Chemistry* only. These are chiefly commercial institutions.

In 1909–10 three fourths of the papers published came from educational institutions and in 1914–15 two thirds of the papers came from the same source. The large increase in the amount of work done in research institutions is notable.

MARION E. SPARKS,
W. A. NOYES

THE AMERICAN SOCIETY OF NATURALISTS

THE thirty-fourth annual meeting of the American Society of Naturalists was held at Columbia University, New York, December 29, and at the Carnegie Station for Experimental Evolution, Cold Spring Harbor, on December 30, 1916. In affiliation with the society this year were the American Association of Anatomists, the American Society of Zoologists and the Botanical Society of America.

The report of the treasurer, stating a balance on hand of $642.80, was accepted.

The following changes in the constitution, recommended by the executive committee, were authorized.

Article II., Section 2, last sentence to read: The name of any member two years in arrears for annual assessments shall be erased from the list of the society, and such person can only regain membership by reelection.

Article III., Section 1 to read: The officers of the society shall be a president, a vice-president, a secretary and a treasurer. These together with three past presidents and one member elected annually from the society at large shall constitute the executive committee of the society.

Article III., Section 2 to read: The president and vice-president shall be elected for a term of one year, the secretary and the treasurer for a term of three years. Each president on retirement shall serve on the executive committee for three years. The member of the executive committee elected from the society at large shall serve for one year. The election of officers shall take place at the annual meeting of the society, and their official term shall commence at the close of the meeting at which they are elected.

A recommendation to remove from the constitution section 3 of Article IV. failed to carry.

A motion that the society shall pay the secretary $50 and the treasurer $25 yearly for their services was laid on the table.

Resolutions, bearing on the working plan of the society, were presented by the executive committee and adopted by the society:

Resolved, that the American Society of Naturalists, composed as it is of the representatives of the several specialized fields of biology, should have as its constant purpose the furtherance of biological research and education in its broadest sense.

Resolved further that for the present the American Society of Naturalists can best attain this end by three forms of activity.

First. The holding of an annual dinner affording an opportunity for social contact among those working for the advancement of biology. On this occasion the president of the society shall have an opportunity through the annual address to express himself on a subject of broad biological interest and significance.

Second. The presentation of a symposium, arranged by the president, on some timely subject or problem relating to biological sciences.

Third. The presentation of a program, to consist primarily of research papers, on problems of organic evolution. The arrangement of this program in all respects, including its length, shall be in the hands of the program committee.

The following resolution offered by Edwin G. Conklin was adopted:

Whereas the National Academy of Sciences, at the request of the President of the United States, has organized a National Research Council for the purpose of promoting and coordinating research work, especially for national welfare, and

Whereas these are in part the purposes of the American Society of Naturalists,

Therefore, be it resolved that the American Society of Naturalists approves the organization of

the research council and desires to cooperate in its work in all ways which may be found practicable.

There were elected to membership: Edward W. Berry, Johns Hopkins University; Calvin B. Bridges, Columbia University; Douglas H. Campbell, Stanford University; E. Eleanor Carothers, University of Pennsylvania; Rhoda Erdmann, Rockefeller Institute; George F. Freeman, University of Arizona; Jann Kempton, U. S. Department of Agriculture; Sidney I. Kornhauser, Northwestern University; Edwin C. MacDowell, Carnegie Station for Experimental Evolution; Charles W. Metz, Carnegie Station for Experimental Evolution; David M. Mottier, Indiana University; Hermann J. Muller, Rice Institute; W. J. V. Osterhout, Harvard University; Edith M. Patch, Maine Agricultural Experiment Station; Alexander G. Ruthven, University of Michigan; William A. Setchell, University of California; Erwin F. Smith, U. S. Department of Agriculture; Alfred H. Sturtevant, Columbia University; David H. Wenrich, University of Pennsylvania.

The program of the Friday morning session, December 29, was as follows:

"Variation and Heredity in Peas," by O. E. White.

"Inheritance of Color Coats in Cats," by P. W. Whiting.

"Triple-allelomorphs in the Rat," by P. W. Whiting.

"Hybrids of *Zea tunicata* and *Zea ramosa*," by G. N. Collins.

"The Axial Rotation of Microorganisms and its Significance in Connection with the Present Theories of Evolution," by L. B. Walton.

"Deficiencies in the Genetic Materials of the Chromosomes of *Drosophila*," by C. B. Bridges.

"The Principle of Regional Inheritance as Exemplified in the Compositæ," by E. C. Jeffrey.

"The Genetic Behavior of *Œnothera cleistantha*." (Read by title.) By George H. Shull.

"Further Considerations of the Records of Alcoholic Guinea-pig Stock," by C. R. Stockard.

"Application of the Laws of Action, Reaction and Interaction in Life Evolution," by H. F. Osborn.

"The Influence of Castration on Hen Feathered Cocks of the P_1, F_1 and F_2 Generations," by T. H. Morgan.

"A Contribution to the Theory of Sex-determination," by R. B. Goldschmidt.

The session of Friday afternoon consisted of a symposium on the subject "Biology and National Existence."

"Biology and Preparedness," by Stewart Paton.

"Biology and the Nation's Food," by W. J. Spillman.

"Biology and Internationalism." (Read by title.) By V. L. Kellogg.

"Biology and War," by Jacques Loeb.

"Biology and Citizenship," by E. G. Conklin.

The Naturalists' dinner was held on the evening of December 29, at the Hotel Manhattan, with one hundred and five in attendance. The president's address by Dr. Raymond Pearl entitled "The Selection Problem," is published in *The American Naturalist* for February.

On Saturday, December 30, members of the Naturalists were most enjoyably entertained at Cold Spring Harbor by the staff of the Carnegie Station for Experimental Evolution. A morning program was held in Blackford Hall with the following papers:

"Parthenogenesis and Sex in *Anthrothrips*," by A. Franklin Shull.

"A Classification of Color Factors in Mammals," by Sewall Wright.

"Evidence of Multiple Factors and Segregation in Mice and Rats," by C. C. Little.

"A New Series of Multiple Allelomorphs in Maize," by R. A. Emerson.

"On a Back Cross Involving Three Allelomorphic Pairs in Mice," by J. A. Detlefsen.

"Congenital Variations in Guinea-pigs and their Bearing on Certain Genetical Problems," by L. J. Cole and H. L. Ibsen.

After luncheon opportunity was given to inspect the equipment of the station and of the Eugenics Record Office, the activities of which were explained by the members of the staff in their several fields of interest.

The officers of the society for 1917 are:

President—George H. Shull, Princeton University.

Vice-president—Leon J. Cole, University of Wisconsin.

Secretary—Bradley M. Davis, University of Pennsylvania (1917–19).

Treasurer—J. Arthur Harris, Carnegie Station for Experimental Evolution (1915–17).

Additional Members of the Executive Committee—David H. Tennent, Bryn Mawr College (1917); Henry V. Wilson, University of North Carolina (1915–17); Frank R. Lillie, University of Chicago (1916–18); Raymond Pearl, Maine Agricultural Experiment Station (1917–19).

BRADLEY M. DAVIS,
Secretary for 1916

SCIENCE

FRIDAY, FEBRUARY 23, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

BIOLOGY AND PREPAREDNESS[1]

THE association of ideas suggested by the words "biology" and "preparedness" probably marks the beginning of a new epoch in history. The careful consideration of the sequence of events that have led to the formal act of linking together these two words should supply material for an interesting chapter in history, and should furnish an impulse strong enough to reawaken in the minds of those who have already left hope behind them rational expectations for a slow but steady progress of civilization.

Science, as one of the chief witnesses to this fortunate union, is relieved of any necessity for explaining that while certain by-products may liberate destructive forces, her aims and methods tend beyond peradventure to conserve both life and energy. In view of the critical times in which we are living, this fact by itself is not even halfway satisfying. The human animal needs the stimulus of positive hope and the knowledge of actual accomplishment; and these will be added to our most treasured possessions when once we shall begin, after centuries of indifference, to make preparations for rational living.

During the last two years we have not only changed our general attitude towards life, but have been made most bitterly aware of the disappointments sure to follow dreams of incredible Utopias, or visions of universal peace. We have paid a high price for our failure to emphasize the greater importance of preparing to live ef-

[1] Read in symposium on "Biology and National Existence," meeting of the American Naturalists, New York, December 28, 1916.

ectively as compared with the special preparations we have thought essential for dying in proper fashion. Prophet, priest and mystic philosopher have urged men to prepare to die, while science has only recently directed attention to the larger duty of preparing to live more efficiently, happily and successfully. We are just beginning to realize that if *to-morrow we die, to-day* we must live.

The mental attitude necessary to appreciate the full significance of the present associations between the words "biology" and "preparedness" also calls for the formulation of a new philosophy of living —a philosophy that will be of more direct assistance in enabling us to face the present with a greater display of intelligence and courage than has hitherto been expended. This is not the time to make a mistake in the choice of the path we are to follow. If civilization is truly symbolized by the figure of a caravan crossing a desert, we can not permit any false prophet to act as our leader. Far better to endure patiently the dangers and trials of our present situation than to incur any additional risk.

In order to comprehend both the scope and spirit of the Preparedness Campaign the character of the forces that have shaped it must be given due consideration. A few of these are obvious, but many are not generally recognized. As a people the majority of us would not admit until forced by circumstances, the truth of the allegation that a vague though compelling sense of unrest and an ill-defined consciousness of lack of preparation for dealing with the critical situations in life, have created at this moment of world-wide crisis a desire both to reorganize our ways of living and to secure protection from invasion of our territory.

The campaign for preparedness, as we see it, has two distinct objects in view, representing double aspects of the same problem: personal and national preparedness. To discuss these two kinds of preparation as unrelated, is both impractical and illogical, because the personal can not be wholly separated from the national aspect. Personally we accept the reality of the presence of disease and face it, because most of us with our backs to the wall must do so. But in case of war, because there is time and opportunity for mystics living with their heads in the clouds to dream of a transformed humanity, some of us still believe that entirely unrelated problems are under discussion.

Preparations for war must be made because the sudden disappearance of its threatening specter could only be brought about by some miraculous metamorphosis in humanity; and the consideration of the probability of this should be left to those who assume the possession of prophetic ability. The extreme superficiality of any thinking that takes for granted the possibility of being able to recommend a method for the great and immediate reduction in the frequency of wars, is revealed in the mere supposition that the roar of guns and clatter of swords are the only sign of war. "When both are silent," said John Bigelow, "war may go on even more fiercely than ever before. Hate, vengeance, jealousy, covetousness, ambition, treachery, cowardice, survive." These conditions no magic touch can remove. When we remember these facts, and consider how few have been the efforts to analyze the genesis of impulses, to ferret out the causes of obsessions, to trace the origin of hatreds, or, to discover methods of controlling emotions without the formation of dangerous repressions, the boast that we can prevent war by the introduction of a change here and there in our social and political systems, has a very hollow sound. Before the outbreak of

the European war Israel Zangwill wrote to the late Mr. Stead:

I take the opportunity of reminding Mr. Stead that more good will be done by facing the brutal facts of life and the European situation than by allowing the wish that war shall cease to be father to the thought that it is ceasing.

Indeed such a thought as Mr. Zangwill sought to oppose merely reflects the fanatic's contemptuous disregard for the necessity of keeping open the approaches to truth even when we ourselves have not the strength to do more.

The same spirit of weakness and disinclination to face life as it is is shown in the intellectualist's efforts to impress us with his ability to live in the world and not be of it. Those who recognize this particular form of complex can easily detect the signs of disappointed ambitions and dissociated personality rather than a lofty and commendable purpose.

A truly high purpose should culminate in a decision to go as straight as we can, without further temporizing, to the root of most of the troubles to which the flesh is heir, and to substitute for an astonishing amount of ignorance as accurate a store of knowledge as can be gathered together. In a reasonably short time the result of working with this object in view would so impress us with the magnitude of our task as to make us reject promptly all promises of salvation bearing the trade-mark of any "ism."

Concrete information of this kind would not only prevent the occurrence of many unpleasant surprises regarding some of the basic qualities of human nature, but would enable us to remove a good many of the causes that lead at critical moments to explosive reactions of great violence, disturbing alike to the development of a well-balanced personality, the cause of democracy, and the progress of civilization. Moreover, we know that if the forces giving shape to personality are not focused, dissociation is the result, with the subsequent development of peculiar mental qualities that possess high explosive potentiality. An excellent illustration of this is wishful thinking, which may become a habit; and when this occurs it forms a menace to orderly thought processes, and results in blocking the peaceful settlement of any questions either personal or national.

These are some of the conditions we fail to recognize because we have become so accustomed to measure the value of brain activity merely by the content of consciousness without considering the character of the processes concerned in the operation. The autocthonous thoughts that are the products of a split-up personality often supply an emotional spark to explode the powder, and on this account we should learn to recognize in the apparently harmless dreamer, to whose reveries we often give encouragement, a source of danger to the community not infrequently exceeding that of the victim of systemized delusions.

For similar reasons there are excellent grounds for not placing too much confidence in the intellectual judgments of any person who disregards logical conclusions and shirks the responsibility concerned in the reconciliation of faith and works; such a man tries first to ignore and then to obliterate every memory of defeat, and resorts to subterfuge to conceal the strong personal disinclination to meet definite issues by absorbing himself in some general scheme for the regeneration of humanity. In such cases it is often the half-repressed memories of a personal struggle ending in defeat that drives the loser to turn aside from the real world and its concrete problems to live in an imaginary one which can only be described in abstract or platitudinous phrases.

Although it would be superfluous to point out the important bearing the analysis of

some of our national traits would have in supplying the information essential for directing our energy to the best advantage, a reference may be made to one glaring example of specific ineptitude due to lack of emotional balance. Consider for a moment the extraordinary opportunity existing at this crisis in world affairs for our universities to make adequate provision for supplying the leaders of thought urgently needed if a triumphant democracy is to be assured. Is the contribution of these institutions to the intellectual awakening now in progress to be measured only by an amateurish interest in military preparedness? Have we not reason to expect, perhaps we may even say to demand, that our universities shall not base their chief claims for recognition as institutions of learning merely upon traditional and hereditary rights? Should they not now set the example of facing squarely the vital issues of the present? One proof that the gravity of the present situation has been appreciated might be found in some effort to break with the restrictive influences imposed by trying to satisfy the parochial notions of the alumni and by placing on governing boards and in administrative offices representative citizens competent to realize the value of scholarship and research and the importance of cultivating broad national ideals. The signs of the times are indeed threatening, but what can we expect in the way of great intellectual leadership from an institution that places so little value upon the influence of example as to retain the services of an athletic coach receiving more than double the recompense of any member of its faculty! Judged by their spirit and works, the universities have failed lamentably to rise to meet the present situation. To-day when we are so earnestly seeking the abolition of petty sectional feeling, and turn to our oldest institutions of learning for a substitute, we find only a Harvard, Yale or Princeton sentiment tending to prevent the development of the idea of service to the general government.

In undertaking to formulate concrete plans for a campaign of preparedness it is advisable to begin with the clear recognition of the collective, binding and directive forces supplied by the present biologic methods of studying human behavior. Upon the adoption of a biologic line of approach, not only apparently unrelated subjects are shown to be intimately dependent, but a still greater change is evident in the new mental attitude developed towards the actual significance of the history of the human race. It has generally been the custom to proceed from the discussion of relatively obscure events in the past to the analysis and interpretation of the behavior of persons now living. The almost exclusive use of this method has left us in profound ignorance of ourselves, and has delayed considerably the presentation of the underlying facts of history in a vital fashion. If we reverse the ordinary procedure and begin with the analysis of the phenomena of behavior by making a first-hand investigation of the processes as they actually take place in individual lives, we shall then be in a better position to advance historical interpretation by making the past live; an accomplishment impossible as long as the approach to the study of human life was along avenues lined by tombs where only records of the dead were visible.

When once the importance of interpreting life in terms of vital reactions is recognized, then we shall find it possible to proceed in a logical and enthusiastic manner to inaugurate a movement that promises to result in greater efficiency and success in living, and in this way an opportunity may be presented of demonstrating that democracy has the power to minister to the biologic needs of men. At present we have become so intoxicated with words that in

order to evade facing a good many pretty stern facts, we are almost ready to accept as efficient any public confession of faith in crude notions about political freedom. We really dread discussing biologic problems.

But what indications are there that we are on the right path of biologic discussion? The efforts to remedy the present neglect of the study of the brain and nervous system are few, because the interest of the general public has not been aroused to the necessity for it. It is a most curious comment upon the lack of interest shown in our universities and institutions devoted to research, that so little attention is paid to making any adequate provisions for increasing our knowledge of these organs—the brain and nervous system—which are commonly esteemed to be the chief stock in trade of institutions of learning. While encouragement is given to those who delight to speculate upon man's place in nature, practically little has been done to assist in the determination of those structural and functional differences of the nervous system that are responsible for our elevation above the plane occupied by our simian ancestors. The time is rapidly passing, as Yerkes has pointed out, when on account of the disappearance of the higher apes it will be possible to trace the various gradations in our ancestral line. Of equal importance to these problems should be the studies made upon the nervous system with the object of correlating the structural and functional changes taking place during the early stages of the life of the individual. With the methods now at our command this particular field of investigation should offer fruitful results to the student. By carrying out these comparative studies a great deal of valuable information could be obtained which would throw light upon the fundamental nature of the adjusting processes and indicate the order followed as the capacity for adaptation was extended.

Think of the extraordinary opportunities existing in New York—the greatest melting-pot the world has ever seen—for the analysis of human behavior! Parents, educators, social workers, physicians, anthropologists, criminologists, eugenists, those endeavoring to find improved methods for increasing industrial efficiency, lawmakers, and all persons interested in the acquisition of knowledge relating to the regulation of human behavior, need to feel the inspiration coming from the realization of working towards a common goal.[2]

It would not be difficult to plan some central organization aiming to coordinate effort and to correlate results in attacking problems that are of the most vital importance for our personal and racial salvation. If we continue merely to dabble the tragic results will be even more appalling than they are to-day. Let us not deceive ourselves any longer nor try to apologize for our failure to understand and direct intelligently human energy by referring as "evidences of organized charity" to the application of remedies to correct the end stages of imperfect adjustment in numberless people.

In addition to a coordinating center of activities there is urgent need in New York for a great university psychiatric clinic dedicated to the investigation of the countless forms of imperfect adjustment generally described as mental disease. To those of us who are familiar with the methods used by the modern alienists to analyze the personality and to trace the genesis of these disorders, it is obvious that their knowledge is absolutely essential for the reorganization of our entire educational system. By the promptness with which

[2] Sums expended annually by the City of New York in directing human energy:

Education	$47,000,000
Protection of life and property	59,000,000
Charities	12,000,000

these objects shall be obtained we may easily estimate both our national intelligence and our peace-loving qualities.

Must it be the grim necessity of war only that shall awaken us to a nation-wide mobilization of all human forces for a single great purpose? Have we the mental capacity to be led by reason rather than driven by necessity "to sacrifice comforts, indulgences, and elegancies" for the purpose of acquiring the knowledge of self without which a practical preparation for living is impossible?

STEWART PATON

PRINCETON, N. J.

THE ECOLOGICAL SIGNIFICANCE OF SOIL AERATION

DURING the past two years the writers have conducted, independently, laboratory investigations into the relation of plant roots to the composition of the soil atmosphere and especially to deficiency of oxygen or excess of carbon dioxide in this atmosphere. These investigations are still in progress and will be reported later. It seems, however, that certain features of the results already obtained have important ecological significance, and this phase of the matter is presented in the present preliminary paper.

One series of experiments was conducted by one of us (Cannon) in the Desert Laboratory of the Carnegie Institution of Washington at Tucson, Arizona, and in the Coastal Laboratory of the same institution at Carmel, California. Seedlings of *Prosopis velutina*, and cuttings of *Opuntia versicolor* were grown in glass tubes filled with sand and connected with a gas reservoir in such a manner that any desired gas or mixture of gases could be caused to replace the ordinary atmosphere of the tubes at will. Each tube was sealed with wax and usually a water seal was used in addition. By the use of appropriate thermostats the tubes were kept at any desired temperature. In all cases the shoots were exposed to the atmospheric conditions of the laboratory. The growth of individual roots was observed directly by means of a horizontal microscope. The experiments included tests with pure carbon dioxide and various mixtures of this gas with atmospheric air or with oxygen.

As a leading result it was learned that the roots of *Prosopis* and of *Opuntia* have unlike responses to carbon dioxide. Exposure to pure carbon dioxide causes cessation of growth in the roots of both species. However, the recovery on the admission of air is uniformly more rapid with *Prosopis* than with *Opuntia.* The two species respond differently, also, to percentages of carbon dioxide which are high but below 100 per cent. Thus mixtures of 50–75 per cent. carbon dioxide with 25–50 per cent. oxygen, do not stop root growth of *Prosopis,* but do stop that of *Opuntia.* Apparently excessive amounts of carbon dioxide in the soil atmosphere would act as a limiting factor for the latter plant, even if the oxygen content of the soil atmosphere was normal or above normal. Neither excess of carbon dioxide nor diminished supply of oxygen inhibits the growth of *Prosopis* roots, for growth did not wholly cease when an atmosphere containing less than 2 per cent. of oxygen was employed. However, entire deprivation of oxygen appears to inhibit growth since the roots did not grow in pure carbon dioxide. Thus while the effects of the undiluted carbon dioxide on root growth of the two species is apparently the same, namely, the cessation of growth, the responses leading to this effect may be quite different.

The conclusion that the root response to a variable ratio of oxygen to carbon dioxide in the soil atmosphere is a specific response, is supported further by the results of direct aeration experiments on several species of plants, among which were *Opuntia, Prosopis, Fouquieria splendens,* and garden varieties of cucumber and watermelon. An increased air supply to the roots of *Opuntia* and *Fouquieria,* if not excessive, favors root branching and probably accelerates the rate of root growth. In the case of *Prosopis,* increased aeration of the soil appeared not to affect the growth rate of the roots. The results with cucumber and watermelon were not consistent, although in the latter case the shoot growth appeared to be

more vigorous when the soil containing the roots was artificially aerated.

The other series of experiments was conducted by one of us (Free) under the direction of Professor B. E. Livingston in the laboratory of plant physiology of Johns Hopkins University. A technique has been devised by which plants of mature size can be sealed into tin cans of about two liters capacity, the shoot projecting through the seal into the open atmosphere. The root system, with the soil in which it grows, is inside the sealed space and the soil atmosphere can be replaced at will by an atmosphere of any desired composition. Water is supplied to the plant by the Livingston auto-irrigator. The controlled atmosphere inside the can is kept automatically at a pressure slightly (about 3 centimeters of water) greater than the general atmospheric pressure, changes of volume due to variable temperatures being compensated. This assures that any slight leakage will be outward and without effect on the experiment.

With this technique experiments have been made on four species: *Coleus blumei, Heliotropium peruvianum, Nerium oleander* and *Salix* sp. (probably *nigra*). With *Coleus* it is found that even a very small decrease of oxygen below that normal to the atmosphere is injurious to the plant. Thus a plant, the roots of which were supplied with gas consisting of 75 per cent. air and 25 per cent. nitrogen, was injured within three days and killed within 45 days. With lower oxygen content in the soil atmosphere injury and death are still more prompt. *Heliotropium* behaves substantially like *Coleus,* except that the period between initial injury and death is shorter. Nerium is much more resistant to oxygen deprivation. With a soil atmosphere of pure nitrogen, injury was first apparent in the shoot after 26 days. An atmosphere of 50 per cent. air and 50 per cent. nitrogen had produced no perceptible injury in 45 days when the experiment was stopped. Dilution of the soil atmosphere with carbon dioxide instead of nitrogen appeared to have a like effect. No evidence was observed of any specific toxic effect of carbon dioxide, though such an effect is not excluded by the experimental results.

The most interesting result was with *Salix.* With this plant entire deprivation of oxygen appeared to be without injurious effect. In an experiment three times repeated the plant grew normally with a soil atmosphere of pure nitrogen, one of the experiments lasting for ten weeks. Replacement of the nitrogen with carbon dioxide and the use of various mixtures of carbon dioxide and air were also without perceptible effect. It appears that this species of *Salix* is quite independent of the content of oxygen in the soil atmosphere. That the respiration of the root cells can be anaerobic is less certain, but is strongly suggested by the data.

The two series of experiments outlined are sufficient to show that different species of plants may differ markedly in their response to variations in the composition of the soil atmosphere, and hence to changes in soil aeration. The effects of diminution of oxygen are manifest and the results with *Opuntia* indicate a direct and specific effect of carbon dioxide in addition to the effect of the dilution of the oxygen.

Though many details are lacking it is known that the composition of the soil atmosphere is neither the same as, nor so constant as, the composition of the general atmosphere. The presence of living matter in the soil, including bacteria, fungi and protozoa, as well as the roots of higher plants, tends to decrease the oxygen of the soil atmosphere and to increase its content of carbon dioxide. Doubtless there are chemical reactions associated with the decay of dead organic matter and which have the same or similar results. This tendency toward impoverishment in oxygen and enrichment in carbon dioxide must be counteracted by diffusion between the soil atmosphere and the general atmosphere, assisted, no doubt, by changes in barometric pressure and in temperature of soil and air. The importance of these assisting agencies is difficult to estimate but the effect of diffusion alone has been shown by Buckingham[1] to be extremely slow. Doubt-

[1] Bulletin 25, U. S. Bureau of Soils (1904).

less in normal cases the soil atmosphere is always slightly higher in carbon dioxide and slightly lower in oxygen than is the general atmosphere. Since the diffusion processes are effected very markedly by the average size of the interspaces between the soil particles, the difference in composition between the soil atmosphere and the general atmosphere will be greatest in the soils of fine texture and least in those of coarse texture. The similar effect of the soil water is obvious, especially the effect of the water existing as films about the grains in diminishing the size of the spaces available for gas diffusion.

The ecological bearing of these facts is manifest. Although deficiency in aeration has frequently been suggested as an agricultural difficulty, or as the reason why certain species do not grow upon soils of heavy texture, it does not appear that this suggestion has had any exact experimental basis, nor does it seem to have been appreciated that different species may have great differences in the oxygen requirement of their roots and widely variant responses to differences in soil aeration, responses which appear to be quite as specific and significant as the responses to temperature and to available water which form the present basis of ecological classification. The importance of root-habits in ecology has long been recognized on the basis of their characteristic and specific reaction to the features of the soil environment included under temperature and water relations. Thus it has been shown that the general distribution of the cacti as a family is closely related to the response of the roots to the temperature of the soil. It seems probable that soil aeration must be added as a factor of no less importance than temperature and water. Thus in the matter of local distribution of cacti, it is probable that the restriction of this family to habitats which have a relatively well-drained soil, in which the accumulation of carbon dioxide during the season of most active root growth is probably relatively slight, may be owing in part to the inability of the roots of these forms to grow well in an atmosphere charged heavily with carbon dioxide. On the other hand, the distribution of *Prosopis* and *Nerium* along the river bottoms, and of *Salix* in swamps, indicates that the presence of a relatively large amount of carbon dioxide in the soil does not act as a limiting factor to these species. Again, Howard[2] notes that the general distribution of the gram (chick-pea) as a crop in India is closely associated with the fact that the roots of this species require a relatively large amount of air. It accordingly occurs only, or mainly, where the soil and the system of cultivation provide an amount of air sufficient for its root growth.

In many semi-arid regions the physiography is such that there are relatively large and shallow basins without outlet, the central portions of which are flooded during rainy seasons but are dry for most of the year. Usually the central flats or playas of such basins have soils composed largely of fine silt or clay, and which puddle easily. It is characteristic of these playas that they are void of plant life during all, or most, of the year, and that no perennials are to be found in the lowest places, even when no excess accumulation of salts in the soil has occurred. It is here suggested that the probable reason for the absence of plant life on such playas is directly traceable to insufficient soil aeration at the time when the soil is suitably moist and of a temperature suitable for the growth of plants. It is interesting, also, that around such playas the plants frequently occur in well-marked bands or zones. Where the zones are found there is probably little difference in the available moisture or the soil temperature and it is suggested that the zonal differentiation may be a result of unlike response of the roots of the plants comprising the zones to the atmosphere of the soil. Whether zonation is to be associated with the relation of roots to the soil atmosphere in places outside the arid regions remains to be seen, but this may well be the case.

W. A. Cannon,
E. E. Free

[2] Howard and Howard, Bulletin 52, Agricultural Research Institute, Pusa, 1915.

SCIENTIFIC EVENTS

THE WORK OF THE AMERICAN MUSEUM OF NATURAL HISTORY

ACCORDING to a press report the trustees of the American Museum of Natural History decided at their annual meeting at the home of Mr. Henry C. Frick greatly to broaden the scope of its work in aiding industrial, civil and artistic life in order to make up for some of the foreign deprivations due to the war.

Because so many American arts and industries have been thrown upon their own resources, the institution will intensify its efforts to make its collections and publications widely and fully available. A review of last year's work noted that the difficulty of obtaining new patterns for dress fabrics and other textiles from abroad has sent designers to the museum stores of American primitive and Indian art. Manufacturers of pottery and other wares, too, are sending their designers to study ancient specimens.

For the extension of the work the trustees adopted the largest budget in its history, appropriating $608,590 for the current year. They subscribed $60,000 among themselves to make up a deficit in the maintenance account in addition to $23,500 they already had subscribed to give to all employees a 10 per cent. bonus. To meet the higher cost of living it was decided to make the increased salaries permanent on a merit basis.

The income from the Morris K. Jesup endowment fund for 1917 was given as $252,500. The museum has received all but 10 per cent. of the $5,000,000 bequest, and expects to have the full amount in the course of the present year. This fund is used exclusively for scientific work, exploration, research and publication.

Dr. Henry Fairfield Osborn announced that among bequests to the institution was one of $250,000 from the estate of Amos F. Eno, of this city, and another of $100,000 from that of James Gaunt, of England. Special attention is to be given this year to the department of anthropology, for the work of which in the last ten years $456,000 has been expended.

The election of officers resulted as follows: *President,* Henry Fairfield Osborn; *First Vice-president,* Cleveland H. Dodge; *Second Vice-president,* J. P. Morgan; *Treasurer,* Henry P. Davison, and *Secretary,* Adrian Iselin, Jr. The choice of trustees for the class of 1921 resulted in the reelection of Charles Lanier, Anson W. Hand, Frederick F. Brewster and R. Fulton Cutting.

The attendance at the meeting was the largest in the history of the institution. Those present were Adrian Iselin, Jr., Joseph H. Choate, Charles Lanier, Percy R. Pyne, T. De Witt Cuyler, A. D. Juilliard, Arthur Curtiss James, Cleveland H. Dodge, John B. Trevor, Professor Henry Fairfield Osborn, Felix M. Warburg, Ogden Mills, Dr. Walter B. James, Madison Grant, Frederick F. Brewster, R. Fulton Cutting, Archer M. Huntington, Henry C. Frick and Cabot Ward.

HIGHER EDUCATION IN WASHINGTON

THE Washington legislature of 1915 appointed an educational commission of three members and three representatives to make a survey of the educational institutions of Washington (State College of Washington, University of Washington and the three normal schools). This commission secured the services of the U. S. Bureau of Education in making the survey, the results of which were recently published as a bulletin by the Bureau of Education. This report recommended the transference of the graduate work in engineering and pure science from the state college to the university, also the transference of several departments from the college to the university. The matter was brought before the present legislature in the form of a bill putting into effect the provisions of this report. This bill, however, failed of passage and in its stead a substitute bill was passed providing:

Sec. 2. The courses of instruction of the University of Washington shall embrace as exclusive major lines, law, architecture, forestry, commerce, journalism, library economy, marine and aeronautic engineering and fisheries.

Sec. 3. The courses of instruction of the State College of Washington shall embrace as exclusive major lines, agriculture in all its branches and

subdivisions, veterinary medicine and economic science in its application to agriculture and rural life.

Sec. 4. The courses of instruction of both the University of Washington and the State College of Washington shall embrace as major lines, liberal arts, pure science, pharmacy, mining, civil engineering, electrical engineering, mechanical engineering, chemical engineering, home economics, and the professional training of high-school teachers, school supervisors and school superintendents. These major lines shall be offered and taught at said institutions only.

Sec. 5. Work and instruction in medicine when introduced or developed shall be offered and taught at the University of Washington exclusively.

The bill further provides for a joint board of higher curricula of nine members chosen from the presidents and regents of the five state institutions of higher learning. In the future all major lines of work taken up by any institution of higher learning of the state must first be passed upon and approved by a two thirds vote of said board of higher curricula.

In addition to this, an act was passed granting in perpetuity to the State College all of the federal land formerly allotted to the state for a scientific school and further provided:

Sec. 2. All funds granted by the United States government under the Morrill act, passed by congress and approved July 2, 1862, together with all acts amendatory thereof and supplementary thereto, for the support and in aid of colleges of agriculture and mechanic arts, as well as experiment stations and farms and extension work in agriculture and home economics in connection with colleges of agriculture and mechanic arts are hereby allotted to the State College of Washington.

GRANTS FOR SCIENTIFIC WORK FROM THE LOUTREUIL FUND

Nature quotes from the *Comptes rendus* of the Paris Academy of Sciences the report of the council of the Loutreuil Foundation. The grants allotted are divided into three groups, as follows:

Establishments Mentioned by the Testator.—(1) Museum of Natural History. Two thousand francs to Professor Louis Roule for the continuation of his researches on the migratory fishes of French marine and fresh waters, the Salmonidæ in particular. Ten thousand francs for refitting the maritime laboratory of the Island of Tatihou at Saint-Vaast-La-Hougue. This laboratory has been used as a concentration camp since the outbreak of war, and considerable damage has been done. (2) The Collège de France. Seven hundred francs to E. Gley to complete the frigorific installation for which an allocation was made last year. Four thousand three hundred and fifty francs to Professor Nageotte for the purchase of apparatus for pursuing his studies on the regeneration of nerves. Four thousand francs to M. l'Abbé Rousselot for continuing and developing the experiments commenced by him on locating artillery by sound. (3) Conseil Central des Observatories. Fifteen thousand francs to the Observatory of Paris for the improvement of astronomical instruments applied to the determination of time. One thousand five hundred francs to the Observatory of Marseilles for ensuring the publication of the *Journal des Observateurs.* (4) Ecole Nationale Vétérinaire d'Alfort. Seven thousand francs to this school for the purchase of an apparatus for kinematographic registration and projection; this will be of great service in the study and demonstration of various movements in the normal or pathological state. (5) Ecole Nationale Vétérinaire de Lyon. Eight hundred and fifty francs to Charles Porcher for the purchase of instruments to be used in his researches on milk. Eight hundred francs to François Maignon for the purchase of a balance and a small hydraulic press, to be used in his researches on nutrition. (6) Ecole Nationale Vétérinaire de Toulouse. Five thousand francs to this school for a radiological installation to be used in the diagnosis of diseases of animals.

Establishments Nominated to the Committee by the President of the Academy.—(1) Conservatoire des Arts et Métiers. Four thousand francs to Louis Blaringhem for the creation of a typical collection for the determination and classification of the woods used in the aeronautic industry. Five thousand francs conditionally to James Dantzer for the creation of a laboratory for the testing of textiles,

fibers, and tissues under the express condition that the Union des Syndicats Patronaux de l'Industrie Textile contributes the same amount. (2) Ecole Nationale Supérieure des Mines. Ten thousand francs to this school for completing the laboratory installation, especially as regards motive power. (3) Institut Catholique de Paris. Two thousand francs to Henri Colin for the purchase of apparatus not usually found in botanical laboratories, to be used in his researches on the conditions of destruction of various bacilli. Two thousand francs to Jules Hamonet for purchasing apparatus for determining the physical constants, particularly refractive indices, of the new substances he has discovered in the glycol group.

Various Direct Requests for Grants.—Ten thousand francs to Jules Garçon for the preparation of a bibliography of bibliographers, a part to be used in making an inventory of the scientific periodicals contained in the libraries of Paris. Three thousand francs to Guillaume Bigourdan for the construction of an angle comparator for measuring the variation which the angular distance of two stars may show in a short interval of time. Three thousand francs to Henri Bourget for his researches on astronomical photometry. Two thousand francs to A. Colson for continuing his researches on solutions. Seven thousand francs to Augustin Mesnager for improving the equipment of the laboratory for testing materials under his direction at the Ecole des Ponts et Chaussées. Two thousand francs to Jules Glover for continuing his researches on telephony. Seven thousand francs to Louis Joblin to complete the publication of his studies relating to the material collected in the second Antarctic voyage of Jean Charcot. Five thousand francs to the Société de Documentation Paléontologique. Two thousand francs to J. M. R. Surcouf for assisting the publication of his work on horse-flies.

The total amount in grants is 115,200 francs.

SCIENTIFIC NOTES AND NEWS

Dr. Vernon M. Slipher, for many years chief assistant at the Lowell Observatory, known for his spectroscopic researches, has been appointed director of the Lowell Observatory in succession to the late Percival Lowell.

Professor George S. Moler, of the department of physics of Cornell University, will retire from active service at the end of the academic year.

At a meeting of the Rumford Committee of the American Academy of Arts and Sciences, held on February 14, 1917, the following grants for researches in light or heat were made: To Professor F. K. Richtmyer, of Cornell University, five hundred dollars in aid of his researches on the optical properties of thin films; to Professor Norton A. Kent, of Boston University, four hundred dollars additional to previous appropriations in aid of his research on spectral lines; to Mr. Ancel St. John, of the Worcester Polytechnic Institute, two hundred dollars in aid of his research on the spectra of X-rays.

At the New York meeting of the Botanical Society of America officers for 1917 were announced as follows: *President,* F. C. Newcombe, University of Michigan; *Vice-president,* E. W. Olive, Brooklyn Botanic Garden; *Treasurer,* E. W. Sinnott, Connecticut Agricultural College at Storrs. R. A. Harper, Columbia University, became a member of the council, and also of the editorial committee of the *American Journal of Botany.* The representative of the American Phytopathological Society on the journal committee is Professor Aaron G. Johnson, University of Wisconsin.

Professor George Hayem has been elected president of the Paris Academy of Medicine for 1918.

The Janssen prize of the Paris Academy of Sciences has been awarded to MM. Ch. Fabry, Henri Buisson and Henry Bourget, for their researches on the determination of the temperature and evaluation of the atomic weights of the unknown gases in the nebula of Orion.

We learn from *Nature* that the president of the British Board of Agriculture and Fisheries has appointed a committee of representative agriculturists to advise him on questions arising in connection with the increased production of food. The committee is constituted as

follows: The Right Hon. R. E. Prothero (chairman), the Right Hon. Sir Ailwyn E. Fellowes (vice-chairman), the Right Hon. F. D. Acland, the Right Hon. Henry Hobhouse, the Hon. Edward G. Strutt, Sir Sydney Olivier (board of agriculture), Mr. W. W. Berry (Development Commissioner), Mr. S. W. Farmer, Mr. F. L. C. Floud (board of agriculture), Mr. A. D. Hall (Development Commissioner), Mr. S. Kidner, Mr. T. H. Middleton (board of agriculture), Mr. A. Moscrop, Mr. H. Padwick (National Farmers' Union), Mr. R. G. Paterson, Mr. G. G. Rea, Mr. E. Savill, Mr. Leslie Scott and Professor W. Somerville. Mr. E. M. Konstam (who has joined the department for the duration of the war) is the secretary of the committee.

The 1916 volume of the *Annals* of the Association of American Geographers, which has just appeared, contains a long descriptive article by Professor N. M. Fenneman on "The Physiographic Divisions of the United States." This is accompanied by a map, the work of a committee of the association consisting of Professors Fenneman, Blackwelder and D. W. Johnson and Messrs. Campbell and Matthes, of the U. S. Geological Survey. Separates and copies of the map may be obtained on application to Richard E. Dodge, secretary, Washington, Conn.

Professor Lafayette B. Mendel, of Yale University, addressed the Sigma Xi Society of the University of Chicago on February 2, and also spoke to the students of the university on the subject of "Nutrition."

Dr. Harry N. Holmes, head of the department of chemistry at Oberlin College, lectured recently on "The Formation of Crystals" at the Mellon Institute of the University of Pittsburgh; Franklin Institute, Philadelphia, and the Johns Hopkins University.

Surgeon-General Sir G. H. Makins, delivered the Hunterian oration before the Royal College of Surgeons of England on Wednesday, February 14, his subject being the influence exerted by the military experience of John Hunter on himself and on the military surgeon of to-day.

On February 28 the Geological Society of London will again have the opportunity of discussing the Piltdown man. The late Charles Dawson had discovered further remains about a mile away from the original locality, but in gravel of the same age. These, which consist of a molar from the lower jaw, a fragment of the occiput, and a part of a frontal including some of the orbital margin, will be laid before the meeting by Dr. A. Smith Woodward.

A movement has recently been initiated to institute, at the Finsbury Technical College, a reference library of chemical books in memory of the late Professor Raphael Meldola, F.R.S., who formerly presided over this school of applied chemistry.

Charles J. White, professor emeritus of Mathematics at Harvard University, died suddenly on February 12.

Mr. John Tebbutt, of Windsor, New South Wales, where he conducted an observatory, has died at the age of eighty-two years.

The death in Rio Janeiro is announced of Dr. Oswaldo Cruz, director of the Oswaldo Cruz Institute of Pathology and Bacteriology, Dr. Cruz was formerly director of the Brazilian sanitary service.

The spring meeting of the American Chemical Society will be held in Kansas City, April 10–14. The program will be arranged as follows:

Tuesday night, April 10—council meeting.
Wednesday morning, April 11—opening session.
Wednesday afternoon, April 11—opening session, continued, or section meetings.
Wednesday night, April 11—smoker.
Thursday morning, April 12—section meetings.
Thursday afternoon, April 12—section meetings.
Thursday night, April 12—banquet, or open.
Friday morning, April 13—section meetings.
Friday afternoon, April 13—excursions.
Friday night, April 13—banquet, or open.
Saturday morning, April 14—excursions.

The Geological Department of the British Museum has recently received, through Sir John Eaglerome, K.C.M.G., an interesting series of vertebrate remains from early Tertiary beds in southern Nigeria. These include a huge carinate bird (*Gigantornis eagleromei*

Andrews, 1916) remains of leathery turtles, and jaws of a primitive Zeuglodont, showing approximation to a creodont dentition.

Dr. Henry J. Berkley, clinical professor of psychiatry in the Johns Hopkins University, has presented the library with a number of rare and valuable medical books, dating from the sixteenth, seventeenth and eighteenth centuries.

In connection with the presentation on January 20 of a loving cup to Mr. Thomas A. Forsyth, one of the founders of the Forsyth Dental Infirmary for Children, Boston, the institution was open for public inspection, both forenoon and afternoon, as it is to be known as "Forsyth Day." Routine work as well as special features were shown in all departments. In the orthodontia department special cases were shown, and in the surgical department, special operations were conducted by Dr. William E. Chenery. Fifteen-minute lectures by John D. Adams, M.D., and Isadore Coriat, M.D., were given on subjects of interest to dentists at 11:30. A research laboratory exhibit was given from 2 to 4 P.M.

Two skeletons of the duck bill dinosaur were lost to science with the sinking recently by a German raider of the ship *Mont Temple*, according to Charles H. Sternberg, of Lawrence, Kans., who found the bones in the red deer country in Alberta, Canada. The prehistoric specimens were thirty-two feet long and were being sent to the British Museum. They filled twenty-two boxes and weighed 20,000 pounds. When the shipments failed to arrive in England, an inquiry was made by Mr. Sternberg and he received word from the Canadian railroad officials of the fate of the shipment.

The United States Department of the Interior has designated Minnesota as one of the three states where mining experiment stations are to be established within a year. The government will appropriate $25,000 annually for the support of such a station and the state must supply the building. The regents have asked for $175,000 for this purpose. There are to be ten such stations established eventually. Minnesota's importance as a mining state has caused her to be selected as one of the first group.

The University of Toronto, through the Antitoxin Laboratory in the Department of Hygiene, has recently been the recipient of a gift from Colonel A. E. Gooderham, Toronto, of a farm of fifty acres on which have been erected model stables and laboratories for the work of the laboratory. The value of the gift exceeds $60,000, and the farm is situated within twenty miles of Toronto. It prepares all the public health biologic products supplied free by the Ontario government, through its board of health, including diphtheria and tetanus antitoxin, anti-meningitis serum, the Pasteur Treatment and smallpox vaccine. The laboratory also prepares all the tetanus antitoxin used by the Canadian Expeditionary Forces. The director of the laboratory is Dr. J. G. Fitzgerald, associate professor of hygiene, University of Toronto.

The Hon. Albert Johnson writes from the United States House of Representatives:

> I tried, immediately on the opening of the session, to obtain a hearing for House Bill 528, for the discontinuance of the Fahrenheit thermometer. With only 52 working days between January 1 and March 4, it is evident that not only this bill, but many other important bills will have no chance to come up for action. The hearing before the committee would have to be repeated at the next session, when the composition of the committee may be very different. The new committee might be influenced to some extent by the report of its predecessor, but such reinforcement of the argument is hardly needed, and would at best be of little weight. It seems to me that any advantage thus to be gained would hardly justify the labor of getting the committee together at a time when its members, like myself, are overwhelmed with other pressing work. In the new Congress, the bill will have to be reintroduced, either at the special session, which now seems a probability, or at the regular session. I shall then make an effort to obtain a hearing with the least possible delay.

The chemical industry in Russia has received great impetus from the war, and, according to *Commerce Reports,* quoted by the *Journal* of the American Medical Association, a number of works have already been erected

and many others are projected. Among them is a formaldehyde factory at Vetluga, and a technical laboratory for the production of lanolin, naphthalene, etc., at Rostov. A large company has been formed at Moscow for the production of coke-benzol products and at Tomsk a chemical factory is projected for the making of medical chemicals. Several new works for making sulphuric acid have been erected in the Volga region, in the Donets basin, in the Caucasus and in the Urals. Mirrors, lenses and other optical instruments, thermometer tubing and chemical glass, formerly imported, are now being made. There is a large demand for microscopes and other scientific apparatus, as well as for articles for medical and surgical use.

At a meeting of the board of managers of the Cold Spring Harbor Biological Laboratory of the Brooklyn Institute of Arts and Sciences, the completion of an endowment of $25,000 for the laboratory was announced. The principal donors are: Mr. W. J. Matheson, estate of Colonel Robert B. Woodward, Mr. Walter Jennings, Mr. A. A. Healy, Mr. August Heckscher, Mr. Cleveland H. Dodge, Mr. Louis C. Tiffany, Mr. Howard C. Smith, Mrs. E. H. Harriman, Colonel T. S. Williams, Mr. Henry F. Noyes, Mr. Albert Strauss and Mr. Donald Scott. It is expected that the laboratory will now become one of the four fundamental departments of the institute, and will be under the special care of a governing committee of the trustees of the institute.

Although New York was not included among the states where a serious fungous disease of poplars was reported by the federal authorities, the State College of Agriculture at Ithaca announces that the disease has been found on Long Island. This disease is similar in appearance to that which destroys the chestnut trees and may be found on any species of poplars or cottonwoods. Trees attacked by this fungus show cankers or depressed areas in the bark, which spread rapidly and often girdling the twig, limb or trunk of the tree and killing the part above the canker; the trees become ragged in appearance and finally die. This is especially true of the Lombardy poplars so often planted in rows along highways. The fungus which causes this disease, according to the authorities, was imported from Europe, and is especially severe on stored and transplanted nursery stock. The centers of infection appear to be, in every case, either certain nurseries known to contain diseased trees, or points where poplars from such nurseries have been planted. Residents of New York who think their trees are affected by the disease may receive exact information by sending samples to the department of plant pathology, New York State College of Agriculture, Ithaca, New York.

The Rizzoli Orthopedic Institute of Bologna has inaugurated an exposition of orthopedic appliances, to be held at Bologna in February under the auspices of the national federation of committees engaged in welfare work for blinded, mutilated and crippled soldiers. The institute has announced a prize of 5,000 lire for the best appliance, and is urging others to collect funds for additional prizes.

Professor L. C. Karpinski writes that the first volume of the "Nouvelles Tables trigonométriques fondamentales" by Professor H. Andoyer, of Paris, mentioned in a recent review in Science as delayed by the war, appeared in 1915. This volume of 341 pages + lxviii pages includes the sines and cosines for each one hundredth of the quadrant to 20 decimal places, for each 9 minutes to 17 places, and for each 10 seconds to 15 decimals.

UNIVERSITY AND EDUCATIONAL NEWS

A gift of $20,000 from Mrs. George Putnam to Harvard University was announced at the last meeting of the president and fellows. The money will be used to establish a fund in memory of Mrs. Putnam's brother, James Jackson Lowell, and the income will be used for the purchase of books for the college library.

Thirty-four thousand guineas have been subscribed to the South Wales University College for the extension of scientific and technical education.

THE University of Stockholm has received from Mrs. Amanda Ruben the sum of 50,000 kroner to found a readership in experimental zoology.

DR. B. C. CROWELL, professor of pathology and bacteriology, University of the Philippines, has been appointed director of the Graduate School of Tropical Medicine and Public Health of that university. This school gives courses which in one year lead to the degree of Doctor of Tropical Medicine and in two years to Doctor of Public Health.

DR. H. B. FANTHAM, of Christ's College, Cambridge, has been appointed to the professorship of zoology at the South African School of Mines and Technology, Johannesburg, and Dr. C. E. Moss, of Emmanuel College, has been appointed professor of botany in the same institution.

WE learn from *Nature* that Dr. Johanna Westerdijk has been appointed associate professor of phytopathology in the University of Utrecht. She is said to be the first woman to receive such an appointment in Holland.

DISCUSSION AND CORRESPONDENCE

THE LIMIT OF THE SPECTRUM IN THE ULTRA-VIOLET

IN the *Astrophysical Journal* for March, 1916, I gave an account of my work in the extreme ultra-violet. During the past year I have continued my investigations in the same field; the results have not been commensurate with the labor, but it is perhaps worth while to make a brief report of them.

I have not changed the general design of my spectroscope but I have replaced the 100 cm. grating by one of 50 cm. radius, thus halving the light path and considerably reducing the volume to be exhausted. My source of light is still a quartz discharge tube, but I have so altered the design that the end of the capillary can be brought much nearer the slit of the spectroscope than before; I have considerably increased the potential of the transformer; as before, I employ helium at one or two millimeters pressure to fill my spectroscope and discharge tube.

The net result of these changes is that I have certainly extended the spectrum from 600 to the neighborhood of 510 Ångströms; a trace of a line exists on my very best negative near 450 Ångströms, but it is far too faint to afford trustworthy evidence.

From time to time during the past five or six years I have tried Wood's miniature arc in vacuum, and a variety of vacuum spark arrangements, recently I have repeated the more promising of these experiments. None of these sources appear to yield lines in the most refrangible region. Helium continues the most promising source.

THEODORE LYMAN

JEFFERSON PHYSICAL LABORATORY,
HARVARD UNIVERSITY, CAMBRIDGE,
February 14, 1917

THE FOUNDATIONS OF DYNAMICS AND DADOURIAN'S ANALYTICAL MECHANICS

MY attention was called recently to a review of the second edition of my "Analytical Mechanics" by Professor E. W. Rettger, which appeared in SCIENCE (No. 1130) last summer when I was in the mountains and did not see it. The review on the whole was favorable and would not have tempted the author of the book to make an answer at this late date were it not for the fact that the two questions raised by the reviewer bear upon the foundations of the science of mechanics.

The first of these is directed against my direct application of the laws of vectors to the directed magnitudes of mechanics:

> Before we apply the law of vector addition to any kind of quantity, ought we not first assure ourselves that the parallelogram law holds for these quantities? Since force, for instance, is a *directed quantity* (italics are mine) does it follow that the parallelogram law holds for forces?

I would answer both of these questions in the affirmative. We have no right to apply vector operations to "any kind" of quantity. We ought to assure ourselves that the quantity in question is a "directed quantity" before treating it as such. But having once assured ourselves of this fact we need not hesitate to apply to it the parallelogram law or any other law of directed quantities.

Vector algebra is the science of directed lines, or displacements, in space as ordinary algebra is the science of numbers. We do not hesitate to apply the laws of ordinary algebra to quantities which can be represented by numbers, we need no more have any compunction about applying the laws of vectors to quantities which can be represented by directed lines. The expression "the law of parallelogram of forces" is a provincialism for which there is about as little justification as there would be for a "law of the addition of apples" in arithmetic. The addition law of arithmetic is a law of numbers and is not peculiar to apples; it can be applied to apples not because they have certain desirable properties, but because they can be counted. Similarly, the parallelogram law is a law of displacements or directed lines, and not at all characteristic of forces, but it can be applied to forces because these have among other physical properties those of direction and of magnitude and consequently may be represented by directed lines.

This is the precise point of view which I have adopted in my book toward the directed magnitudes of mechanics. After giving a clear and concise exposition of the laws of addition and resolution of vectors in the first chapter I have applied them to directed quantities without hesitation. This mode of procedure is not only correct, but it is straightforward and simple, as the reviewer admits when he says:

> If the author is correct . . . then certainly the theory underlying the composition and resolution of directed quantities becomes very simple.

The second question which Professor Rettger raises has to do with my formulation of the principle underlying the science of dynamics. In my book I have based dynamics upon the following principle, which I have called the *action principle:*

The vector sum of all the external actions to which a system of particles or any part of it is subject at any instant vanishes.

$$\Sigma \mathbf{A} = 0.$$

A particle may be acted upon by other particles and by the ether. The action of one particle upon another particle is known as a force. The action of the ether upon a particle I have called a *kinetic reaction.* Therefore the action principle states

$$\Sigma(\mathbf{F} + \mathbf{q}) = 0,$$

where $\mathbf{F}$ denotes a force and $\mathbf{q}$ a kinetic reaction. The kinetic reaction on a particle is oppositely directed from and proportional to the acceleration and the constant of proportionality is the characteristic constant of the particle known as mass. Therefore we have

$$\Sigma(\mathbf{F} - m\,\mathbf{a}) = 0.$$

Commenting upon this principle, Professor Rettger says:

> The reviewer does not wish to say that the author is wrong in his conception. All he wishes to say is that he entirely fails to appreciate the author's point of view.

This lack of appreciation is due, it seems to me, to a lack of clear understanding, indicated by the following questions, of the nature and function of the kinetic reaction.

> Why is it that the ether acts on a body only when it is being accelerated and not when the body is moving with constant velocity?
>
> If kinetic reaction is the action of the ether on a particle, and if it is the same kind of a quantity as force (is a force in fact), and if the resultant force F acting on a particle and the kinetic reaction q are always equal in magnitude but opposite in direction (both equal to ma in magnitude), why is the body not in equilibrium?

If in the first of these questions the term "why" is used in the metaphysical sense, there is no answer for it, except possibly the equally metaphysical answer "because." On the other hand, if it is used to mean "how is this fact correlated with other facts?" I would state that the answer belongs to electrodynamics and not to mechanics and would refer the reviewer to a modern treatise on electrodynamics, Lorentz's book on "Electron Theory," for instance, where the question is answered at length.

Answering the second question, one might state: "The body is not in equilibrium for the same reason that a particle revolving in a circle is not in static equilibrium in spite of

the fact that the so-called 'centrifugal' and 'centripetal' forces acting upon the particle are equal and oppositely directed." I am afraid the reviewer has overlooked the fact that a particle is in static equilibrium when and only when the sum of the forces due to other material bodies acting upon the particle equals zero. When this condition is not satisfied the particle is accelerated and by virtue of the acceleration the kinetic reaction comes into play. This kinetic reaction is equal and opposite to the resultant of the forces due to the material bodies. If it were not for the kinetic reaction a finite force would have given a body an infinite velocity in a finite time.

The kinetic reaction is of the same nature as a force and might be called a force, but that would tend to confound the cause with the effect. It would further necessitate changing the statement of the conditions of equilibrium as well as of motion. It was in order to keep the old concept of force as an action which causes acceleration and to distinguish between cause and effect that I refrained from applying the term force to kinetic reactions.

The concept of kinetic reaction is not new. It has been known to other authors of textbooks of mechanic as *centrifugal force, inertia force,* or *inertia reaction.* The thing that is new about kinetic reaction in my book is the full recognition it receives and the clear cut treatment which differentiates it from accelerating forces. I have preferred the name kinetic reaction to inertia reaction because it is just as much an acceleration-reaction as an inertia-reaction.

I claim that the point of view which I have adopted in my book has important philosophical and pedagogical advantages over the common point of view. The former has enabled me to differentiate between purely geometrical laws and dynamical principles, between kinematical relations and dynamical equations, between what is fundamental and what is derived in mechanics. I have postulated a single dynamical principle which is not only simple and sound, but is correlated with the equally fundamental principles of electrodynamics. Upon this single principle I have based the entire subject, deriving from it all the other dynamical laws and principles used in elementary mechanics, such as Newton's three laws of motion, the principles of the conservation of energy, of linear momentum and of angular momentum.

Before closing this communication I would like to call the attention of teachers of mechanics to the following principle which I have introduced in the second edition of my book and have called it the *angular action principle.*

The vector sum of all the external angular action to which a system of particles or any part of it is subject at any instant vanishes:

$$\Sigma \mathbf{A}_a = 0,$$

or

$$\Sigma (\mathbf{G} + \mathbf{q}_a) = 0,$$

where $\mathbf{G}$ denotes the moment of force about a given axis and $\mathbf{q}_a$ denotes the moment of the kinetic reaction of a particle about the same axis, the latter I have called the *angular kinetic reaction.* This principle, which is directly applicable to rotating systems, is equivalent to and derived from the action principle.

It can be easily shown from the angular action principle that the torque equation

$$G = I \frac{d\omega}{dt}$$

holds good only when the center of mass of the moving system remains at a constant distance from the axis of rotation, a point which has eluded most authors of textbooks of mechanics.

In conclusion I would state that the two action principles are simple statements of the following two sets of equations used in general dynamics.

$$\begin{aligned}
&\Sigma (X - m\ddot{x}) = 0,\\
&\Sigma (Y - m\ddot{y}) = 0,\\
&\Sigma (Z - m\ddot{z}) = 0,\\
&\Sigma [y(Z - m\ddot{z}) - z(Y - m\ddot{y})] = 0,\\
&\Sigma [z(X - m\ddot{x}) - x(Z - m\ddot{z})] = 0,\\
&\Sigma [x(Y - m\ddot{y}) - y(X - m\ddot{x})] = 0.
\end{aligned}$$

H. M. DADOURIAN

YALE UNIVERSITY

THE SYNCHRONIC BEHAVIOR OF PHALANGIDÆ

PROFESSOR H. H. NEWMAN's note in a recent number of SCIENCE reminds me that in 1901 I

made precisely the same observations on the behavior of colonies of the same species of harvestmen (Phalangidæ) in the neighborhood of Austin, Texas. These colonies are not uncommon, nesting in masses on the lower surfaces of overhanging rocks along the canyons of the Colorado River and its tributaries and in the Edwards Plateau region. The colony described by Newman was unusually large, as I do not recall seeing any that were much more than a foot or a foot and a half in diameter and comprising, perhaps, between two and three hundred individuals. The rhythmic, simultaneous, up and down movement of the creatures on their long sensitive legs, when disturbed, is very striking. Merely approaching the spot where the Phalangids are congregated is sufficient to set the whole assemblage vibrating. The stimulus in this case is probably the air-current produced by the sudden approach of the observer and is probably propagated, as Newman suggests, by contact among the interlaced legs. In many cases of synchronic behavior, however, other stimuli must be assumed. In fireflies the initiation of the simultaneous flashes must be due to optic stimuli, as it is in people endeavoring to keep in step with one another, but the continuation of the established rhythm would seem to depend on a kind of "Einfühlung." Such is undoubtedly the impression produced on one who witnesses the rapid wheeling movements of a herd of prong-horned antelopes on our western plains or the flight of certain birds. Some years ago I observed that pelicans flying in single file over the Bay of Panama exhibited a very pronounced synchronism in the beat of their wings. In this case I was led to assume that after the members of a flock had established the synchronism, probably by visual stimuli, it was kept up by a fine sense of rhythm on the part of each individual.

W. M. Wheeler

Bussey Institution

MORE COMPLETE TITLES

To the Editor of Science: When the student of the structure or the functions of animals needs to consult the literature dealing with any form on which he has worked, he meets at the outset with the difficulty that a large number of papers to which he turns fail to show in their titles the names of the animals that were used.

In view of this familiar, but none the less unfortunate, state of affairs, I wish to inquire through your columns whether there is any valid objection to the suggestion that authors in some way incorporate in their titles the names of the animals used for their investigations.

In some cases common names would answer, but more often the binomial Latin form would be required. In the case of little known forms, and especially in the case of insects, it would be of great help if the family or order were also given.

Should there be no serious obstacle to the step here suggested, the improvement could easily be inaugurated by the concerted action of the editorial boards of our several biological journals and those heads of departments and bureaus through whose hands forthcoming manuscripts naturally pass.

Henry H. Donaldson

The Wistar Institute,
Philadelphia, Pa.,
February 3, 1917

SCIENTIFIC BOOKS

Milk and Its Hygienic Relations. By Janet E. Lane-Claypon, M.D., D.Sc. Longmans, Green & Co. 1916.

This admirable book has been published under the direction of the Medical Research Committee (National Health Insurance, England). The chief aim of the author "is to present a survey of the existing knowledge upon such aspects of the milk question as hitherto has been inaccessible or difficult to obtain by most of those desiring it."

The scope of the book includes a consideration of the composition, "biological properties," and cellular content of milk; the nutritive value of raw, boiled and dried milk; the presence of organisms liable to cause disease, and milk-borne epidemics; the sanitary production of milk, types of bacteria, methods of

heating milk and the presence of pathogenic bacteria in butter and cheese.

Foreign sources have been drawn upon exhaustively, and complete bibliographies are listed at the end of each chapter.

Of special interest are the chapters dealing with the nutritive value of raw, boiled and dried milk in infant feeding. A strong case is made in favor of boiled milk, which will be a matter of gratification and confirmation to pediatricians who are championing this cause in America. The evidence for dried milk is not convincing, but in general is favorable.

The chapters on the production of milk and "Methods Commonly Used in Heating Milk" are disappointing. In the former we are surprised to learn that in England "there are no means for keeping milk cool during transit" and the author does not insist upon the need for this. So important a matter as the grading of milk is relegated to the appendix! Pasteurization is inadequately treated. The practise is exceptional in England, but this seems no excuse for not presenting a fuller discussion.

The text includes 348 pages and 8 plates. Non-technical summaries of each chapter precede the more detailed discussion, which is a great convenience to the reader. The book is a most valuable contribution to our literature on milk.

C. M. HILLIARD

SIMMONS COLLEGE

Fungoid and Insect Pests. By F. R. PETHERBRIDGE. Edited by MESSRS. T. B. WOOD and E. J. RUSSELL, under the Farm Institute Series, 1916. Pp. 174. Cambridge University Press.

This little book is well printed and well illustrated but is not extensive enough as to the number of diseases and pests discussed to justify the title. It can hardly serve as a very general reference for farmers and market gardeners as the authors have hoped. The life histories and remedial measures for some fungus and insect pests are taken up. As a short reading text or bulletin to familiarize the public with mycological methods and to indicate possible remedial measures for control of a few pests, it contains interesting matter.

In their introductory parts—1 and 2—the authors have not drawn as close distinctions as to what constitutes diseases as might be wished. It is now hardly allowable to teach that plant diseases may be caused by "unsuitable surroundings such as unfavorable conditions of soil or weather," nor have they made very clear the distinction between infectious diseases and the ravages of animal or insect pests. Note for example: "We have dealt with some of the plant diseases caused by fungi and will now turn our attention to those caused by members of the animal kingdom. By far the greater number of these diseases are due to the ravages of insects."

Insects are effective carriers of disease, but it is safe to say that there are few farmers who would think of the work of the cabbage-leaf butterfly, the wire worm, the army worm, the May beetle or of grain weevils as diseases.

The strongest feature, perhaps, consists in the suggestive statement of remedial measures associated with each disease or insect under consideration. The facts are, generally, well grouped, though in some cases the subjects of chapters and the text overlap, as in Chapters 2 and 3. On page 46 there is a particularly good photograph of common potato scab over the legend: "Figure 15. Potato Scab—the cause of which is not known." No other discussion is given upon this disease and thus the facts are not properly conveyed. Bearing further on the limited scope of the text, no mention is made of any diseases of small fruits or of orchard and shade trees and but slight attention is given to the commonest garden crops.

H. L. BOLLEY

NORTH DAKOTA AGRICULTURAL COLLEGE

SPECIAL ARTICLES

IS SPECIES-SPECIFICITY A MENDELIAN CHARACTER?

IN a recent book[1] the writer raised the question whether or not the phenomena described

[1] "The Organism as a Whole," G. P. Putnam's Sons, New York, 1916.

under the name of genus- or species-specificity are Mendelian in character. It is obvious that a definite answer to this question would be of fundamental importance for the problem of evolution. If species-specificity is not a Mendelian character, we are confronted with the possibility that Mendelian mutations may not have been the only essential factor in evolution.

The phenomena of species-specificity are, as far as we know at present, exclusively determined by the proteins. Phenomena of cytolysis by foreign blood or extracts of foreign tissues, the precipitin and the anaphylaxis reactions can apparently not be produced by any other constituent of an organism than the proteins; and the two or three exceptions reported to this general rule may have been due to impurities in the substances used for the experiments.

A decision of the question of heredity mentioned might be possible by comparing the species-specificity of a hybrid with that of the two parent forms. If it could be shown that the species-specificity of a F_1 hybrid is identical with that of only one of the two parents, no matter whether this parent is the paternal or maternal species, we might consider this an indication that species-specificity is Mendelian; if the species-specificity of a F_1 hybrid, however, is always identical with that of the maternal form, no matter from which of the two parent forms the mother is selected, it might indicate that the cytoplasm of the egg determines the inheritance of the species-specificity.

Experiments of this kind meet with the difficulty that only closely related species can be crossed successfully and in closely related species the differences in species-specificity are generally too uncertain to permit a definite conclusion. In the splendid work of Reichert and Brown on the "Differentiation and Specificity of Corresponding Proteins and other Vital Substances in Relation to Biological Classification and Organic Evolution,"[2] it has been shown that the corresponding hemoglobins of different species are not identical, and "that their peculiarities are of positive generic specificity and even much more sensitive in their differentiation than the precipitin test." In their book they describe the hemoglobin crystals of the horse and the mule, but not those of the donkey. It seemed of interest to make the series complete in order to find out whether or not the hemoglobins of the mule resemble more closely the maternal or paternal form. A decisive result in favor of a Mendelian origin of the specificity could only be had if the hemoglobin crystals of the F_1 hybrid were identical with those of only one of the two parent forms, otherwise the result would decide neither for nor against a Mendelian inheritance of species-specificity.

[2] Carnegie Institution Publication, No. 116.

The writer obtained donkey blood, the hemoglobin crystals of which were prepared and analyzed by Professor A. P. Brown, of the department of mineralogy at the University of Pennsylvania, who was kind enough to communicate his results to me in a letter which with his permission I take the liberty of publishing here.

May 4, 1916

Dear Dr. Loeb: I suppose you have come to the conclusion that I have forgotten all about your samples of the donkey blood, containing no oxalate, which you so kindly sent me; but I have been working upon them as my time permitted and I think that I can now venture to state that in the orthorhombic [or what I have called the "α-oxyhemoglobin"] constant differences may be observed; and these indicate that in this substance the blood of the donkey more closely resembles the blood of the horse than it does that of the mule. I place more weight upon the results obtained from the *orthorhombic* crystals than upon those deduced from the *monoclinic* crystals for the reason that the monoclinic crystals obtained from all three bloods show a strong tendency to twin and these twins are what we call "mimetic twins." The name "mimetic" is applied to them because they mimic or imitate a higher grade of symmetry than they really possess. For instance, these monoclinic crystals approach in their angles those of the hexagonal system and are indeed what we call pseudo-hexagonal. For these somewhat plastic crystals, by the way they twin, average their asymmetries (*i. e.*, their departures from pseudo-hexagonal symmetry) until they become, in their angles,

really hexagonal. The outline of the crystal plate then comes to be bounded by curved (not straight) lines which show the hexagonal angles at the place where this average adjustment is most perfect. This curving of the bounding outlines renders the measurements variable and these measurements I regard as untrustworthy. The true hexagonal angle is 60° or 120° and the pseudo-hexagonal (but really monoclinic) angle may be 123° or 124° or its supplement and the influence of this produces its curving. Examples of such curving outlines to these crystals produced by this sort of twinning may be seen in Reichert and Brown "Crystallography of Hemoglobin, etc.," on Plate 3, Figs. 14 and 18, and Plate 4, Fig. 19, and the "regular growth" of the methemoglobin (hexagonal) over the oxyhemoglobin crystals (monoclinic but pseudo-hexagonal) which sufficiently approaches the true hexagonal angles of the methemoglobin to enter into regular growth with this substance is illustrated on Plate 4 in Figs. 20–23 in the case of shad blood. It is this pseudo-symmetry which renders the measurements of such twinned crystals uncertain and inconstant. Fortunately this difficulty does not apply in the case of the orthorhombic crystals of the bloods under consideration, nor indeed in the case of the majority of orthorhombic crystals, although this tendency to mimetic twinning must always be borne in mind. I do not think it need be considered in the case of the orthorhombic crystals of either the donkey, horse or mule, which are the animals under consideration. But the measurements of the *monoclinic* crystals from the blood of these three animals are rendered uncertain and are made variable by this tendency to mimetic twinning. Therefore it is to the orthorhombic crystals that I must turn to formulate any conclusions as to the likenesses or the differences in these bloods. Fortunately in the unoxalated blood that you sent me the production of crystals is easy, and, while their measurement is not easy, I think that you may rely upon the results obtained; at least they are as reliable as I can make them with my present methods. The results from these orthorhombic crystals as compared with those of horse and mule are given below.

	Axial Ratio $a:b:c$	Prism Angle (Normals)	Macrodome Angle (Normals)
Horse	0.7467 : 1 : 0.4097	73° 30′	57° 30′
Donkey	0.7522 : 1 : 0.4144	73° 54′	57° 42′
Mule[3]	0.7813 : 1 : 0.4198	76° 00′	56° 30′

[3] Donkey ♂ and horse ♀.

These measurements appear to indicate, as I said at first in this letter, that the crystals of "α-oxyhemoglobin" of the donkey approach more nearly those of the horse than they do those of the mule.

Very sincerely yours,

(Signed) AMOS P. BROWN

It is impossible to utilize these results for or against the idea that species-specificity is a Mendelian character. In view of the bearing on the problem of the inheritance of species-specificity the writer thought that even these negative results might be of some interest.

A further difficulty which besets the solution of this problem is that the terms species and genus are selected on a morphological basis and not according to the protein reactions involved in the phenomena of species-specificity.

JACQUES LOEB

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
NEW YORK

THE AMERICAN PHYSICAL SOCIETY

THE eighty-sixth meeting of the American Physical Society was held at Columbia University, December 26–29, 1916. Sessions on Tuesday afternoon, Thursday forenoon and afternoon, and Friday forenoon and afternoon were joint sessions with Section B, American Association for the Advancement of Science, and were held at the School of Journalism. The two sessions on Wednesday were joint sessions with Sections B and C and were held in Havemeyer Hall. The following program of papers was presented:

A Proposed New Form of Seismograph. Herbert Bell.

The Velocity of Sound in Gases in Metal Tubes, as a Function of Density. Karl K. Darrow.

Measurements in Frictional Electricity. L. E. Woodman and N. R. French.

The Preparation of Metallic Mirrors, Transparent Metallic Prisms and Films by Distillation. Otto Stuhlman, Jr.

Our Part in the Advancement of World Physical Science. L. A. Bauer.

Some Experiments Concerning Magnet-Photography. L. A. Bauer and W. F. G. Swann.

On Growth of Crystal Structure in Selenium. F. C. Brown.

Experimental Evidence for the Parsons Magneton. L. O. Grondahl.

The Effect of Pressure on the Resistance of Metals and a Possible Theoretical Explanation. P. W. Bridgman.

The Infra-red Absorption Bands of Gases and the Application of the Quantum Theory to Molecular Rotations. Edwin C. Kemble.

A Criticism of the Rutherford-Bohr Atomic Hypothesis, based upon a Theorem of Phase Equilibrium of two Electrons. Albert C. Crehore.

A Physical Conception of the Reason for the Existence of Planck's Constant "h" based upon the Classical Electrodynamics. Albert C. Crehore.

The Magnetization of Iron, Nickel and Cobalt by Rotation and the Nature of the Magnetic Molecule. S. J. Barnett.

The Internal Structure of Atoms. A. W. Hull.

A New Count Method of Determining the Elementary Electrical Charge. Harvey Fletcher.

A Lecture Demonstration of the Capture of Ions by Falling Drops. E. P. Lewis and W. A. Shewhart.

Some Undescribed Disintegration Products of Radioactive Elements. Fanny R. M. Hitchcock.

Recent Progress in Spectroscopy. (Vice-presidential address before Section B). E. P. Lewis.

The Photo-Electric Effect of Radiations in the Extreme Ultra-violet. James Barnes.

Aluminum and Mercury Atoms under an Electric Field. Reinhard A. Wetzel.

Photography of Spectra in Red and Infra-red Regions. William F. Meggers.

A Relationship between Fluorescence and Planck's Radiation Law. E. H. Kennard.

The Infra-red Arc Spectra of the Metals of the Fe Group. H. M. Randall and E. F. Barker.

Some Spectra in the Photographic Infra-red. Charles F. Meyer.

The Effect of Longitudinal Alternating Magnetic Fields Upon the Hysteresis Curves Produced by Slowly Varying Currents in a Series of Iron-Carbon Alloys. C. W. Waggoner and H. M. Freeman.

Experiments with the Electric Furnace on the Anomalous Dispersion of Metallic Vapors. (By title.) Arthur S. King.

The Effect of Oxygen on the Production of Band and Line Spectra in the Electric Furnace. (By title.) Arthur S. King.

A Polarization Flicker Photometer. Herbert E. Ives.

Test of Absorption Screen for Optical Pyrometry. E. P. Hyde, F. E. Cady and W. E. Forsythe.

A New Direct Reading Precision Refractometer with Uniformly Divided Scale. G. W. Moffitt.

The Minimum Potential Required to Excite the Balmer Series of Hydrogen. James Barnes.

Impact of Electrons on Mercury Atoms. C. D. Child.

The Stark Effect. Reinhard A. Wetzel.

A Proposed Method for Measuring Disturbances in the Earth's Magnetic Field. (By title.) Herbert Bell.

The Kathodo-Luminescence Produced by Certain Tribo-Luminescent Salts of Zinc. (By title.) C. W. Waggoner.

Variations in Glow Discharge Produced by a Longitudinal Magnetic Field. R. F. Earhart and C. B. Jolliffe.

A Time-Current Equation for Making Iron Passive. C. McCheyne Gordon.

A Calorimetric Resistance Thermometer. S. Leroy Brown.

A New Design of Mercury-Break Buzzer for Generating Electrical Oscillations, and a Study of the Use of Other Buzzers in Radio Measurements. Chas. Moon.

The Reflectivity of Tungsten. W. Weniger and A. H. Pfund.

A Determination of C_2 of Planck's Radiation Law. (By title.) C. E. Mendenhall.

The Range of Recoil Atoms from Actinium Emanation. L. W. McKeehan.

The Intensity of X-ray Spectra. (By title.) Arthur H. Compton.

The Distribution of the Electrons in Atoms. Arthur H. Compton.

The Effect of Transverse Joints on the Magnetic Induction in Iron and Nickel. S. R. Williams.

A Resonance Method for Measuring the Phase Difference of Condensers of Fixed Capacity and a Comparison of Resonance and Bridge Methods. J. S. Ward.

The Thermophone as a Precision Source of Sound. H. D. Arnold and I. B. Crandall.

A Uniformly Sensitive Instrument for the Absolute Measurement of Sound Intensity. E. C. Wente.

Note on the Ionization Manometer. O. E. Buckley.

An Accurate Method for the Determination of Surface Tension. W. D. Harkins and F. E. Brown.

Surface Tension, Total Surface Energy, Solubil-

ity, Emulsification and Polar Setting in Surfaces. W. D. Harkins.

The Variation of the Mobility of the Negative Ion with Temperature in Air of Constant Density. Henry A. Erikson.

Intensity of Emission of X-rays from Metals. C. S. Brainin.

Extension of Recently Published Work on Ionization Potentials. J. C. McLennan.

The Significance of Certain New Phenomena Recently Observed in Preliminary Experiments on the Temperature Coefficient of Contact Potential. (By title.) A. E. Hennings.

The Energy of Emission of Photo-electrons from Film-coated and Non-homogeneous Surface. A Theoretical Study. (By title.) A. E. Hennings.

The Possibility of a Science of Experimental Meteorology. B. P. Weinburg.

A Proposed Method for the Photometry of Lights of Different Colors. (By title.) Irwin G. Priest.

At the joint sessions on Wednesday with Sections B and C of the American Association for the Advancement of Science, the following papers were presented by invitation.

Radiation and Atomic Structure. (Presidential address before the American Physical Society.) R. A. Millikan.

The Atom and Chemical Valence. G. N. Lewis.

Molecular Resonance and Atomic Structure. Robert W. Wood.

The Evolution of the Elements as Related to the Structure of the Nuclei of Atoms. Wm. D. Harkins.

The Relation of Magnetism to the Structure of the Atom. Wm. J. Humphreys.

The Relations of Magnetism to Molecular Structure. Albert P. Wills.

The Structure of Solids and Liquids, and the Nature of Interatomic Forces. Irving Langmuir.

Electromerism: A Case of Chemical Isomerism Resulting from a Difference in Distribution of Valence Atoms. Lauder W. Jones.

The following responded to invitations to discuss the papers: Wm. Duane, A. C. Crehore and K. G. Falk. Mr. Falk read the discussion of J. M. Nelson. The discussion was then thrown open and participated in by W. F. G. Swann, A. G. Webster, M. I. Pupin and others.

Many physicists attended the addresses Tuesday evening of the retiring president of the American Association for the Advancement of Science, Director W. W. Campbell, of the Lick Observatory, on "The Nebulæ," and the special program of Section D, Friday evening, on "The Inter-relationship of Engineering and Pure Science." This session was held at the Engineering Societies Building and was followed by a reception to visiting members of the A. A. A. S.

At a short business session the result of the mail ballot for the election of officers was announced. R. A. Millikan, H. A. Bumstead, A. D. Cole and J. S. Ames was reelected president, vice-president, secretary and treasurer respectively. H. A. Wilson and G. O. Squier are the new members of the council. F. Bedell is reelected managing editor, and O. M. Stewart, N. E. Dorsey and Wm. Duane are elected on the editorial board of the *Physical Review*. The reports of the treasurer and the managing editor were presented and on motion, accepted. (These will be printed and mailed to all members.) It was announced that the next meeting of the society would probably be in connection with the Midwinter Convention of the American Institute of Electrical Engineers at New York, February 14-16.

The subscription dinner on Thursday evening was attended by about eighty, and was much enjoyed. The exhibit of new apparatus and results in the Commons Building was open from 4 to 6 P.M., daily, and on Friday afternoon the instruction and research laboratories for physics in Fayerweather Hall were on exhibition with members of the teaching staff in attendance. For these courtesies and many others the society is indebted to Director Geo. B. Pegram, who also had charge of the physics portion of the apparatus exhibit.

The attendance at this meeting was record-making, about 325 at the joint sessions on Wednesday and about 200 at most of the ordinary sessions. The number of new members elected at the meeting was forty, which also probably establishes a new record.

A. D. COLE,
Secretary

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 562d regular and the 37th annual meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, December 16, 1916, called to order by President Hay at 8 P.M. with 23 persons present.

Annual reports of officers and committees were submitted.

Election of officers for the year 1917 resulted as follows:

President, W. P. Hay.

Vice-presidents, J. N. Rose, A. D. Hopkins, Hugh M. Smith, Vernon Bailey.

Recording Secretary, M. W. Lyon, Jr.

Corresponding Secretary, W. L. McAtee.

Treasurer, Ned Dearborn.

Members of Council, N. Hollister, J. W. Gidley, Wm. Palmer, Alex. Wetmore, E. A. Goldman.

President Hay was elected a vice-president of the Washington Academy of Sciences.

Ex-president Evermann then gave an illustrated lecture regarding the present condition of the museum of the California Academy of Science and on its aims and aspirations. Dr. Evermann's lecture was discussed by Messrs. E. W. Nelson and Vernon Bailey.

M. W. Lyon, Jr.,
Recording Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

The 116th regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club at 8 P.M., December 5, 1916, President T. H. Kearney presiding. The program of the evening consisted of a symposium on the behavior of hybrids in different groups of plants.

Mr. G. N. Collins called attention to the increased vigor of the first generation hybrids of Indian corn which is particularly marked in strains which have been widely separated geographically. Variability was found to be somewhat more characteristic of the second than of the first generation. Horny or sweet endosperm is perhaps the best example of a simple Mendelian character pair thus far encountered in maize. Horny and waxy endosperm are completely alternative but the departures do not conform to the expected ratio.

Mr. O. F. Cook stated that when distinct types of cotton are crossed there is usually evidence of increased vigor and hardiness. As a rule, the first generation is intermediate between the parents, while the splitting is pronounced in the second and later generations, but with no cases of complete return to the ancestral types. A great deal of correlation or coherence in characters is often shown in the second and subsequent generations. The increment of selection which has been developed in the parent stock previous to crossing is totally lost in hybridization.

Mr. H. V. Harlan called attention to the sharply contrasting characters in the barley group. Such characters as the following: hulled and naked, black and white, hooded and awned are inherited in the 1–3 ratio.

Among the wheats, Dr. C. E. Leighty stated that nine groups are available for hybridization. The first generation shows increased vigor and greater uniformity. Most of the characters are intermediate. In most cases the behavior in subsequent generations can be explained on the basis of Mendel's law. Wheat hybrids are often fixed and many of the good commercial strains have originated in this way.

The behavior of wheat and rye, oats and asparagus hybrids was discussed by Mr. J. B. Norton. A distinct coherence of characters is shown when naked oats are crossed with the ordinary hulled type. If *Asparagus davuricus*, a Chinese species, is crossed with *Asparagus officinalis*, the progeny resembled in most cases the Chinese mother, especially in dropping their branches in the fall. When these hybrids were crossed back with *Asparagus officinalis*, the second generation showed none of the abcission phenomena exhibited by the mother parent, although the expected ratio was 1–1.

Resistance to wilt disease in hybrids of cotton, okra, watermelon and cowpea was discussed by Dr. W. A. Orton. In the first generation of cotton hybrids, wilt resistance is dominant; in the second generation a large percentage of non-resistant plants are produced. Selected wilt-resistant plants produced a third generation with marked increase in resistance. In the case of cowpea wilt resistance is limited to a distinct variety, "the Iron." In the case of watermelon the citron or stock melon was used in breeding for disease resistance.

In hybrids of the Soy bean Mr. W. J. Morse found the characters investigated to behave as Mendelian characters and segregate according to the Mendelian ratio. The only interrelation of characters was noted in the case of the flower and the hypocotyl, white flower being associated with green hypocotyl and purple flower with purple hypocotyl. Studies were also reported on cowpea and alfalfa.

The great differences in the behavior of citrus from other groups mentioned was discussed by Mr. Walter T. Swingle, who called attention especially to the large amount of variability occurring in the first generation hybrids. Many of these first-generation hybrids are of commercial value and may be propagated without variation from seeds which contain usually only false embryos originating from the nucellar tissues of the mother plant. In a few cases there is a true second generation.

Mr. L. C. Corbett and Mr. William Stuart took part in an informal discussion which followed the regular program.

H. L. Shantz,
Corresponding Secretary

SCIENCE

Friday, March 2, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

GEOGRAPHICAL DISTRIBUTION OF THE MARINE ALGÆ[1]

In connection with some work I am attempting along the line of geographical distribution, it has become desirable to make some sort of a survey of the entire literature of the marine algæ, to classify it and to note the influence of various writers in developing the different lines of geographical study. The progress of the knowledge of the marine algæ has been slow in comparison with that of most other groups and the progress of our knowledge of the geographical distribution has been slower still. Much of this is due to the comparatively limited access to living material, the difficulties of collection, and the lack of any extensive economic value.

In attempting to arrange the literature, as indicating the progress of thought and development, it has seemed best to separate the lines of work formally, and somewhat arbitrarily, into several more or less distinct, yet necessarily overlapping and intertwined groups of subjects. The subjects finally selected as bearing either directly or secondarily on geographical distribution are five, viz., taxonomy, morphology and development, floristics, physiology and geographical distribution. It is, of necessity, an impossible matter to segregate all the literature and arrange it definitely under one or another of these groups. Certain writers have written along two or more of these lines and in the later literature, particularly, several lines of thought and

[1] Address of the vice-president and chairman of Section G, Botany, American Association for the Advancement of Science, New York, December 27, 1916.

research are often found in combination. Nevertheless, both writers and works, as a rule, follow a main trend and may be arranged under one or another of the principal subjects, although important contributions under a different subject may also be included. Each of the subjects, in turn, may be divided into periods according to the principal influence at work and the progress along a special line of development. One period naturally passes over into another, the way being prepared by those writers whose work may be termed anticipatory and the inception of a new period being marked by some writer, or group of writers, whose advance is more pronounced and whose innovations have had the greatest influence. In taxonomic lines, the beginnings are to be found in the earliest writers, both botanical and non-botanical, and the progress in the study of the marine algæ was necessarily slow until the study of more and more of the more complex plants had pointed the way and, to some extent at least, the methods.

Naturally the earlier work on the marine algæ, as on higher plants, was taxonomic, particularly descriptive. In the earlier period mere mention was made in general, but Morison, Ray, Hudson, Dillenius and Linnæus, for example, laid the foundations upon which Goodenough and Woodward, Gmelin, Turner, Esper, Poiret, De Candolle and others built more solidly. Gmelin (in 1768) published the first book on marine algæ, entitling it "Historia Fucorum." In the latter portion of this first period Roth and Stackhouse prepared for the coming of a more logical treatment, especially as to genera. The older method divided the species of algæ between such polymorphic and indefinite genera as *Fucus, Ulva, Conferva, Byssus* and *Tremella*. Roth and Stackhouse added a few new ones, but these are also mostly of extensive application and of indefinite character.

The second period of taxonomic progress dates from 1813, when J. V. Lamouroux published his "Essai sur les genres de la famille de Thassiophytes non articulées." Lamouroux practically instituted genera in very much the modern sense and laid the foundation for future work. Henceforth both the general morphology and the character of the fructification were taken into account in taxonomic work. Besides Lamouroux Bory de Saint Vincent, C. A. Agardh and Lyngbye were responsible for advance in the earlier part of this second taxonomic period. They were succeeded by Greville, Montagne, Decaisne, J. G. Agardh, J. D. Hooker, W. H. Harvey, Kützing, J. E. Areschoug, Ardissone, Zanardini, Ruprecht and others.

The latter part of the second taxonomic period is merged with and came under the influence of a more careful morphologic and histologic study and a closer attention to the structure and development of the organs of fructification. Kützing did much to promote this in his "Phycologia Generalis" (1843) and his "Tabulæ Phycologicæ" (1845–1869). Naegeli, Cramer, Zanardini and others assisted in the same direction. These works mark the passing over into the third distinct taxonomic period which may be said to have begun with Thuret and Bornet and which has continued down to our own times. Its earlier inquiry into the nature of the reproductive bodies dates from Thuret's classic researches on the zoospores and antheridia of the algæ (1845–1855). This was continued into the discoveries as to the modes of development of the cystocarp in the red algæ and all came as a culmination of the similar work by Pringsheim, Naegeli and others. The magnificent "Notes Algologiques" (1876, 1880) and "Etudes Phycologiques" (1878) will long remain as examples of the finest contributions along these various lines of histolog-

ical and developmental researches. The progress along this line has led to other studies of histological and developmental details. These in turn have led up to the present condition, when it seems desirable to make a new and more detailed study of all species, but especially of those credited with a wide geographical distribution or with great variability.

The third and latest period of taxonomic development has resulted in a newer view of specific limitation, in other words, has resulted in specific segregation being carried to a much greater degree than hitherto, yet seemingly not beyond reasonable limits. The results may be seen from Kjellman's treatment of *Galaxaura* (1900), Falkenberg's treatment of the *Rhodomelaceæ* (1901), A. and E. Gepp's treatment of the *Codiaceæ* (1911), Sauvageau's treatment of the *Sphacelariaceæ* (1900–1914), Howe's treatment of *Halimeda* and other genera (1905–1914) as well as of other groups, Foslie's treatment of the crustaceous corallines, Boergesen's treatment of the algæ of the Danish West Indies (1913–1916), my own treatment of *Scinaia* (1914), and others. In my own study of various genera of the red algæ, both from the point of view of morphological differences and of geographical distribution, it is necessary to more carefully distinguish and separate the true species in the case of many aggregates and to scrutinize very carefully those species credited with extended or widely discontinuous distribution. The results throw a much clearer light on certain seemingly troublesome points of geographical distribution, both climatic and topographical.

The anatomical and histological aspects of the morphology of the marine algæ were earlier treated of in connection with the taxonomy. In the first period of taxonomy, the study of the structure both of the vegetative and reproductive portions was slight, although some progress was made through Reaumur (1711), Stackhouse, Turner and others. In the second taxonomic period, Lamouroux gave a great impetus to the study of structure and the distinctions between the different methods of fructification and towards the last of this second period the knowledge of structure was placed on a fairly firm basis.

It was during the third taxonomic period that the study of morphology may really be said to have originated as a separate subject and much of the credit for properly emphasizing it came from Thuret, both by his own publications and by those in connection with Bornet. Since then many special papers dealing with the adult or developmental morphology have been published. Cytological work, too, has been carried on to a considerable extent. The cell membranes have been studied by Correns and others; the chromatophores by Schmitz and his successors; various cell contents, including the plasma massing in the cells of iridescent marine algæ by Berthold and others. The study of the nucleus and its division has engaged the attention of many investigators from Schmitz (1879) through Fairchild, Swingle, Farmer, Strasburger, Osterhout, Williams, Wille, B. M. Davis and Oltmanns. Yamanouchi and Svedelius, in particular, have investigated the chromosome number in connection with the alternation of generations of red algæ. The morphology, both gross and minute, of holdfasts, vegetative and reproductive organs, have been, and still are being, given most careful attention, in connection with taxonomic, physiological and ecological investigations.

While most attention has been turned towards the morphology and development of the marine algæ, their special physiology has received some attention. By far the greater portion, however, remains to be done. It is impossible to more than call

attention to some main lines of work in this communication. The physiological effects of the pigments by Gaidukov, Rosanoff, Reinke, Schütt and Kylin; metabolic activities of various sorts such as those dealt with by Loew and Bokorny, by Hansen, Wille, Arber, Artari and a host of other investigators; the physiology of reproductive processes by Klebs; the method of production of lime incrustations by Lütgeb; the influence of external surroundings by Oltmanns. The physiologico-anatomical researches of Wille and his pupils may be mentioned here. The influence of light, temperature, specific gravity of the sea water, chemical stimuli, etc., have been touched upon by various authors, but these important physiological bases for explaining the facts of geographical distribution and particularly of ecological distribution are still most obscure.

To deal with the geographical distribution of plants it must be recognized that there are several methods of approach, and in dealing with the geographical distribution of the marine algæ, the methods of approach are, in general, the same as those used in dealing with other plants. The first efforts are floristic and usually largely taxonomic. Species are defined more and more accurately and floras are made out for larger or smaller coast lines. Then comes a comparison of floras with one another as to percentages of common or differing species. Cosmopolitan or widespread species are discussed, as are also endemic species, or at least species of more restricted areas and finally the comparison of floras leads to a discussion of the relation of floras as to origin, spread, etc.

Less has been done in the floristics of marine algæ than in that of terrestrial plants. There are comparatively few floras, although many lists have been published. One of the earliest marine floras or lists was that of Goodenough and Woodward for the British Fuci (1797) in which only 72 species were described. This was followed by that of Turner (1802), who enumerated and described 78 species. These included only the species of *Fucus* as then understood. Greville in his Algæ Brittanicæ (1830) greatly increased the number and Harvey in the two editions of his Manual (1841 and 1849) as well as in the Phycologia Brittanica (1846–1851) brought the number up to 388, while Holmes and Batters in their lists of British Algæ (1890, 1891) enumerate 557 species. C. A. Agardh's Synopsis Algarum Scandinaviæ (1817) is another early algal flora as is also Lyngbye's "Tentamen Hydrophytologicæ Danicæ" (1819). More modern is the "Algues Marines du Cherbourg" (1864) of A. Le Jolis and one which has had great influence as a model. One of the earliest accounts to contain a direct comparison between a particular marine flora and other marine floras is Farlow's "Marine Algæ of New England" (1881), in which the comparison is made in the percentage of species between the various subdivisions of the New England coast and also between them and the flora of various parts of Europe, of the Arctic Regions and of the Pacific Coast of North America. Martens (1866) had previously made such a comparison in detailed list between various divisions of the tropical marine flora. Other writers have attempted to classify floras as to their content of species common to or characteristic of other regions as well as those confined to their own region. The most formally floristic papers as to geographical distribution of marine algæ are those of George Murray on "A Comparison of the Marine Floras of the Warm Atlantic, Indian Ocean and the Cape of Good Hope" (1894) and of George Murray and E. S. Barton on "A Comparison of the Arctic and Antarctic Marine Floras" (1895). These papers deal with the percentage of endemic species and

of those common to two or more subdivisions and lay particular stress on the relative number of species to the genus in the various geographical divisions or subdivisions.

The results of this purely floristic work on the marine algæ has been, just as has happened more extensively in phænogamic floristics, the separation of floras more or less distinctly marked off from one another and in some cases the discovery of definite demarcation points. As illustrations of this may be mentioned the following: the Arctic and Mediterranean marine floras were readily understood, but the intermediate floras were not distinguished, nor were there any sharp points or districts of demarcation discovered. The marine flora of the Cape of Good Hope region has always been recognized as very distinct, but the exact limits have never been determined. On the eastern coast of North America, on the contrary, and especially on the coast of New England, not only was the northern flora recognized as different from that of Long Island Sound and southward, but also the Cape Cod Peninsula was indicated as the region of demarcation between the two. This was first mentioned by W. H. Harvey in the first part of the "Nereis Boreali-Americana" (1851). Harvey divides the east coast of North America into 4 divisions, viz., "First, the coast north of Cape Cod, extending probably to Greenland; second, Long Island Sound, including under this head New York Harbor and the sands of New Jersey; third, Cape Hatteras to Cape Florida;" and "fourth, Florida Keys and shores of the Mexican Gulf." This dividing up of the marine flora of the eastern coast of North America is the first division of any definiteness for that of any extended coast and corresponds fairly closely to the zones of the marine flora into which my own investigations indicate it should be divided. Harvey's statements in the "Nereis Boreali-Americana" result from his ideas formulated in the second edition of his "Manual of the British Marine Algæ" and are a direct application of the earlier ideas of Lamouroux (1825, 1826). Along with the separation of floras is a comparison, as to similar latitudes and isothermal lines, between the east coast of North America and the coasts of Europe, but these isotherms are lines of mean annual temperature and likewise are those of the air, but not of the water, indeed for application to land floras, and not affecting, as a whole, at least, the marine flora. This work of Harvey was the first detailed attempt to associate floristic methods with the factors which control climatic distribution.

Later developments of the floristic idea are to be found in Kjellman's work, especially in the "Algæ of the Arctic Sea" (1883) and in the works of Simmons (1897) and of Börgesen and Jönsson (1905) on the marine flora of the Faeroes and the North Atlantic. The Baltic Sea was studied as to its marine flora by Reinke (1889), Svedelius (1901), and Kylin (1906, 1907), that of New England by Farlow (1881) and Collins (1900), that of Iceland by Jönsson (1912), tropical floras of the Indian and Pacific Oceans by Schmitz (1896) and Schroeder (1902), and the antarctic floras by Gain (1912). All these works have been along the same general lines.

To sum up the results of the floristic work, general climatic regions have been set off and distinguished from one another, methods of and agents in dispersal have been discussed, demarcation points between floras have been determined, centers of distribution have been emphasized, and barriers to dispersal have been surmised. All these lead toward the discussion of climatic distribution and to some extent toward that of topographical distribution or ecology. Yet these are all more floristic in style and

point of view than from the standpoint of geographical distribution in relation to definite factors controlling it.

The idea of geography as applied to plant life, while present in indefinite form in the treatises of the Greek period, came as a revolutionary idea to the German Fathers and their immediate successors. It was Alexander von Humboldt, however, who, early in the nineteenth century, gave the first real impulse to the idea of the study of the geography of plants (1805) and the climatic conditions, climatic zones and altitudinal zones which are to be associated with, and to be taken account of in connection with it. It was J. V. Lamouroux, however, who first formulated the outline of topics connected with the distribution of "Hydrophytes" (marine algæ) in 1825 and 1826. Lamouroux had for his models the works of von Humboldt, A. P. De Candolle and Robert Brown on "Aerophytes." It is of interest to notice the topics brought forward by Lamouroux. In the first place, the basis for his study, as he states, consists of some 1,200 species of his own collections and those of the various botanists of Paris, and including specimens collected in many voyages to distant parts of the world. He touches upon species which are, in a sense, cosmopolitan and speaks of the Ulvaceæ or sea lettuce family, as being distributed from the poles to the tropics. This is particularly in connection with the temperature factor and he remarks that the number of species is greater in the temperate zones than in the very cold or very warm zones. In treating of the distribution of families, he makes the point that because of the configuration of coast lines, their distribution from a center is linear rather than radiating as in land plants. He mentions seasonal temperature effects in that the period of higher temperature in any locality shows the greater number of species. He also suggests that possibly the depth relation to distribution is the same as the altitudinal relation to land floras and that there may possibly be expected an arctic or frigid marine flora in the depths of tropical waters, as a frigid land flora is found on high peaks in warm zones. Lamouroux takes up the influence of light, of the aeration of the water and of the plant exposed more or less often and more or less completely by the ebb and flow of the tides. The substratum receives some attention from Lamouroux and also a considerable attention is given to the distribution of the particular divisions and families. Altogether Lamouroux has treated of a considerable number of facts and factors underlying even the more modern consideration of the subject. Greville (1830) and W. H. Harvey (1849, 1851), as has already been stated, have followed Lamouroux and have treated of the geographical relationships of the various floras, but chiefly from the point of view of floristics. Lamouroux and Harvey laid the chief emphasis on general climatic factors, of which temperature is by far of widest effect and importance, and this view was followed by the later writers, who associated factors with their floristic treatment. A new impetus was given the study of climatic distribution by Kjellmann's various papers, particularly by "The Algæ of the Arctic Sea" and the later subdivisions of the Polar Sea. The discussion of the marine floras of the North Atlantic at the hands of Reinke, Simmons, Boergesen and Jönsson simply emphasizes the importance of this climatic factor or sets of factors.

Before leaving this more general treatment, it may be well to speak of Piccone's work (1883) as the only general treatise, other than that of Lamouroux, on the geographical distribution of the marine algæ. Piccone treats of the general features of an algal flora and the general conditions, such as the substratum, both as to physical and

chemical aspects as well as the modes of attachment to and the various methods of aggregation of the algæ on it. He considers also the aspects of chemical composition and variation in salinity of the sea water, as well as its purity, its gas content, its density and its color. There follows a discussion of the influence of the temperature of the water, of the influence of light, of color of the water, of methods of dispersal by currents and by fishes, of the nature of spores, etc. Finally the general organization of the plants themselves is dealt with.

Under the head of climatic distribution and with the controlling factor of temperature in mind, may be mentioned my own papers on this subject in 1893, 1903 and 1914, respectively, where there is an attempt made to outline certain climatic zones depending primarily upon the mean temperature of the surface waters. In these papers I have treated in a general and preliminary way of temperature zones, 5° C. apart, as to surface waters and mean maximum temperature. I have also briefly touched upon the invasions of these zones at seasons of other temperatures, particularly at the mean minima, by species from other zones. These invasions account for much of the seeming disturbances of uniformity and exclusiveness of flora. I am now prepared to account for other invasions due to the raising of temperature of the algæ in tidal belts and in shallow areas, such as salt lagoons and estuaries through the temperature of the air. Through these factors practically all invasions or overlappings from one zone into another, may, as it now seems to me, be explained.

Turning from the papers which are generally floristic or which deal only with the general climatic factors, there are certain papers dealing with the topographical or ecological distribution. While Lamouroux hinted at certain features such as the influence of aeration in the tidal belts and the influence of the substratum, the first papers to deal with topographical features of distribution for marine algæ were those of J. G. Agardh (1836) and Oersted (1844). Both divided the shore belts of the Danish and southwest Swedish coasts into three regions, the uppermost characterized by a predominance of the green algæ, the middle by the predominance of brown algæ, and the lowermost by that of the red algæ. Oersted, however, was the first to attribute this division into regions to a definite influence, viz., to the light as to depth penetration and as to color. Kjellman, later and in several papers, also divides the shores generally into three "regions," the littoral, the sublittoral and the elittoral. He also developed the idea of algal formations, or, as they are more properly called, of "associations." In both these segregations, Kjellman is followed by most later writers.

Rosenvinge for Greenland, Boergesen for the Faeroes, Kylin for the western coast of Sweden and Jönsson for Iceland have applied and extended the ideas of Kjellman as to topographical units and the factors controlling them, as well as for factors of climatic importance. Jönsson (1912) has given a particularly complete and satisfactory outline and discussion.

Schimper, Warming and Clements have given classifications of the marine, as well as the fresh-water algæ, distinguishing the plankton or swimming forms from the benthos, or attached forms, and, in distinguishing the benthos formations according to the substratum, viz., as to sand or rock and in making even farther distinctions.

Two papers of recent date contain data and observations of great importance in topographical distribution of the marine algæ. One of these is the contribution of B. M. Davis (1913) to the "Biological Survey of the Waters of Woods Hole and Vicinity," while the other is the paper of K.

Yendo (1914) "On the Cultivation of Seaweeds with Special Accounts of their Ecology." In each of these papers attention is called to ecological factors modifying or illustrating the workings of general factors of distribution as well as those concerned in special topographical distribution.

To sum up the general results and to attempt to determine the general subdivisions of the coast lines to satisfy all requirements of geographical distribution, the following seems to be a reasonable, although tentative, arrangement, both as to climatic and as to topographical divisions.

CLIMATIC

I. *Zones,* regulated by temperature of the warmer months, especially to be determined by the mean summer temperatures or in practise by the isotheral lines at intervals of 5° C.;

II. *Regions,* purely geographic segregations under zones;

III. *Provinces,* subdivisions of regions according to mean winter temperatures, in practise by isocrymes, 5° apart or less;

IV. *Districts,* subdivisions under provinces according to geographical remoteness and varying physical conditions of a general nature;

TOPOGRAPHICAL

V. *Formations,* aggregations of algæ of same general form, depending particularly upon substratum;

VI. *Associations,* aggregations of algæ depending for general likeness of plant form, etc., on depth (belts), salinity, light, aeration, etc., generally characterized by the predominance of a single, or at most, of a few species.

W. A. Setchell

University of California

THE CARNEGIE INSTITUTION OF WASHINGTON AND SCIENTIFIC RESEARCH[1]

Numerous references have been made in preceding reports to the growing realization of the world at large that the methods of science are the most effective methods thus far developed for the advancement of learning and for the mitigation of the consequences of the inexorable "laws of nature" which condition existence on our planet. Reference has been made likewise to the contemporary rise and progress of other research establishments and to the introduction of investigation as an economic adjunct to industrial enterprises. These manifestations of popular approval and confidence continue to be among the most noteworthy signs of the times. Indeed, it is plain that we are now witnessing a remarkably rapid evolution of public understanding of the meaning and the value of research. This has been greatly intensified and accelerated by the European war, whose sinister aspects appear to be relieved in some degree by the prospects of an awakened realization of the availability of better methods than those of warfare for settling international disputes, of better methods than those now commonly applied in the government of states, and of better methods in education, in sanitation, in industry, and in biological economy generally. The European war has emphasized to a degree not hitherto attained in the world's history the perils of ignorance, of government by assumed divine right, and of that sort of diplomacy which shades off by insensible degrees into duplicity; and it has emphasized equally clearly the necessity for rational investigation of and progressive reforms in all national affairs.

How the details of this evolution, in which the institution must participate, will

[1] From the report of the president for 1916.

work themselves out is impossible to predict except in general terms. It may be safely inferred, however, from the history of similar developments, that this one will proceed much more slowly and with much more difficulty than many enthusiastic optimists anticipate. Evolution is, in general, a secular process and goes on with a leisurely disregard of individuals. It may be safely inferred also that many of the numerous fallacies which have beset the institution during the brief interval of its existence will recur again and again in the rise of similar organizations, while fallacies of a more troublesome type are likely to beset the introduction of the methods and the results of research in governmental affairs. It is in the latter affairs that the most stubborn opposition to progress is usually met, since there exist, as a rule, in such affairs no adequately developed relations of reciprocity between those best qualified to suggest and to formulate improvements and those who control the machinery for their applications. Such improvements can be secured only by overcoming a stolid adherence to precedent as well as the reluctance of rational conservatism. Thus it happens in governmental affairs that the most incongruous ideas often coexist, as is well shown by the contemporary adoption of the most advanced principles of sanitation in certain European countries which are still dominated by medieval theories of the functions of a state. To cite another illustration readily understood and verifiable, it is an anomalous fact that the United States government exacts no professional requirements for the direction of its highly technical affairs except in a single branch of its service, namely, the legal. And in line with this glaring national deficiency it is notorious that the fiat of an executive can make an astronomer, a geodesist, or a biologist out of a man whose works are unknown in the annals of the science of which he becomes the ex-officio representative. We hear much also in these days of the "mobilization of genius" in the interests of national preparedness for commercial and industrial competition, if not for the more serious exigencies of national defense; but it is to be feared that this mobilization means fruitless attempts to utilize aberrant types of mind, or perhaps the employment of men of talent under the direction of those whose competency for leadership is admitted, if at all, only in quite other fields of activity than those here considered. In the meantime, it is plain enough, in the light of current events, that any nation whose governors mistake necromancy for science, confound invention with investigation, or fail to utilize effectively available and advancing knowledge, is in danger of humiliation in peaceful international competition if not in danger of extinction in international conflict.

Much, perhaps too much, has been said in preceding reports concerning the maxims and the principles which should be observed on the administrative side in the conduct of research. To a great extent these maxims and principles are the same as those developed in the common experience of the race; but to a greater extent they are derived from the more concrete and the more sharply defined experience developed in the evolution of the older sciences. All experience teaches that effective research depends on painstaking labor, arduously, patiently and persistently applied; while all science teaches that research is effective only in those regions wherein something like demonstration can be attained. If investigations can not be well done they are of little worth; if nothing can be proved they are of still less worth, or at best only of negative value. But obvious as these truisms are when stated by themselves, they have been con-

tradicted daily in the plexus of events which make up what our successors will call the history, recorded and unrecorded, of the institution. Thus it has been suggested not infrequently that promising researches be suspended in order that equally or less promising researches might be taken up; and it has happened that proposals to abolish departments of research have been seriously advanced before these departments have had time to prove their rights to existence. It is not infrequently suggested, likewise, by otherwise irreproachable correspondents, that the experts of the laboratories and observatories of the institution be set at work under the direction of amateurs, or, in some cases, of those even who have not reached that earliest stage of capacity in science.

It goes without saying that all such untoward influences should have little effect on the rise and progress of a research establishment; but he would be an incompetent administrator who failed to recognize the existence and the dangers of these influences. Most men are still opportunists; many contemn principles and theories of procedure; while the characteristic defect of deliberative bodies, strikingly illustrated by legislative assemblies, is lack of deliberation. Moreover, what any organization, altruistic or otherwise, may accomplish at any epoch, or during any period, will depend very largely on the status of contemporary public opinion. No organization may be rationally expected to rise much above the level of the ideals of those who support and direct it. The law of averages and the "law of conservation of ignorance" apply in the business of research no less rigorously than in other affairs of human endeavor. The only difference is that in research, from the nature of the case, we are held to stricter accountability; it is incumbent on us to be alive to the ideals and the theories which lead to regress as well as alive to the ideals and the theories which lead to progress.

Although popular opinion continues to look upon the institution as an establishment of unlimited means, and hence of unlimited capacities, it is an easily ascertained fact that such advances as have been attained are due chiefly to concentration of effort in a few fields of investigation, the number of these being necessarily limited by the finiteness of income. Of the agencies which have contributed most to these advances the departments of research must be given first rank when quality and quantity of results accomplished are taken into account. These departments have supplied also a much needed verification of the axiom hitherto admitted in all domains of activity except those of research, namely, that if any good work is required the best way to get it done is to commit it to competent men not otherwise preoccupied. They have verified, likewise, the equally obvious truth that large and difficult undertakings demand foresight and oversight, prolonged effort, and a corresponding continuity of support. The idea that discoveries and advances are of meteoric origin and that they are due chiefly to abnormal minds has been rudely shattered by the remorseless experience of the institution.

Along with these considerations special mention should be made of another of vital importance to the departments of research. This is their complete autonomy within the limits of their annual appropriations. Allusion is made to this matter here partly for the purpose of correcting public misapprehension concerning the relations of these departments to the institution as a whole, and partly for the purpose of stating formally the theory of administration followed by the institution during the past twelve years. Such a degree of freedom accorded to the departments of research is

not only necessary by reason of the extent and the complexity of the affairs of the institution, but it should be regarded as a fundamental principle of sound administration. No one can follow the details of all these varied affairs. A division of labors is indispensable, and to the greatest extent practicable the director of a department of research should be encouraged to be the autocrat of his departmental destiny. But in so far as departments are granted liberty of action it is an equally fundamental principle of administration that they should assume corresponding responsibilities. Autonomous freedom and reciprocal accountability are then, in brief, the essentials of the theory under which the departments of research have evolved.

In consonance with the theory just indicated and in conformity with the precedent set a year ago, no attempt is made here to furnish abstracts of the current departmental reports. They give sufficiently condensed summaries of departmental activities and departmental progress. They are, as a rule, highly technical papers and difficult of adequate appreciation even by those somewhat familiar with the subjects considered. But this is not only just as it should be, but it is inevitable if the investigations under way are worth making. Our confidence in them must be founded in large degree on the general principles revealed in the advancement of science. Great and admirable achievements were attained by the ancients prior to the epoch of recorded history; still greater achievements were attained by the Greeks, the Arabs, and the moderns down to the epoch of Galileo and Newton; while competent judges have estimated that greater progress was secured in the nineteenth century than during all previous history. It is quite within conservative reason, therefore, to assume that if we continue to follow those principles, now grounded in more than twenty centuries of repeatedly verified experience, in the light of accumulated and recorded knowledge, we may confidently expect to achieve corresponding further advances.

The question is sometimes raised as to how the efficiencies of investigators and of departments of research are, or possibly may be, estimated. Occasionally, also, there seems to be entertained along with this question the hypothesis that research is a commodity and that money is the chief agent in promoting its effective increase. But the currently common meaning of efficiency implied in this question and in this hypothesis is too narrow for application here. It applies rather to machines and to aggregates of men working like machinery for predetermined economic ends. In a broader sense, however, the question of efficiency of men and of organizations is worthy of considerate attention. It is, indeed, in this inclusive sense, a question of the greatest importance, especially in all cooperative enterprises of communities and states. But without going into these larger aspects of the matter, it may be said that the efficiencies of the investigators and of the departments of research of the institution are determined in the same way that justification for the institution, as a whole, is determined, namely, by the consensus of competent opinion. In science, the work of an individual is measured on its merits and the work of an organization is weighed in the same manner. Adequate tests and standards for what is not fully known may not be wisely set up in acts of administration. Severer tests and higher standards are supplied automatically and relentlessly by contemporary criticism and by the verdicts of posterity. Hence, given a corps of trained investigators, or an organization of several such, the question of efficiency is happily one which is decided for us mainly

by those who are alone qualified to render adequate judgment.

Like all other branches of the institution, the division of research associates has undergone a distinct evolution. Originally a division which gave rise to excessive and often unrealizable expectations, it has gradually become shorn of its extrinsic appendages and divested of its inheritances from occultism. In spite of these omnipresent obstacles to progress and to efficiency, this division has been highly productive from the beginning and continues to be one of the most important agencies of the institution for the promotion of learning. The main reason for the noteworthy success of this agency is very simple. It was stated in a recommendation concerning research associateships, in the report of the president for the year 1906, in these words:

> The limitation of eligibility for such positions to investigators of proved capacity for and of proved opportunity for research.

In the meantime, the number of those possessing such qualifications has increased much more rapidly than the resources of the institution (or than the resources of all research agencies combined) have increased to meet this and other growing financial needs. Not only has income failed to keep pace with worthy demands, but, as repeatedly pointed out hitherto, the purchasing capacity of income has steadily declined since the foundation of the institution. Thus it happens that now, just as the merits of the system of research associates have come to be generally recognized, it is essential to suspend extension of this system, and it may become essential to curtail to some extent the amounts of the grants hitherto made to those who have helped most to develop this remarkably effective division of the institution's activities.

It should be evident from the preceding paragraphs of this section of the report, as well as from numerous passages in previous reports, that the income of the institution is not only not equal to popular estimates, but that it is not equal even to the legitimate demands on it for research. This proposition is easily verified, although few people believe it and fewer still are willing to undertake the small arithmetical labor essential for its demonstration. On the other hand, it is admitted by everybody that the institution is not doing as much as it could, but the simple reasons for this obvious fact appear to be far from equally obvious. Whether it would be desirable, if practicable, to double, say, the endowment, and hence the income, of the institution is a question well worthy of consideration. But along with many reasons why it would be so desirable there might be adduced also many other reasons why it would not. This is, indeed, a fundamental question whose deliberate consideration should precede the next step. We possess as yet no well-defined and generally accepted theory of a research organization. The institution, plainly enough, stands somewhat in isolation. It would prosper better, probably, and be better understood, certainly, if it had more contemporaries with which to divide not only the vast fields of opportunity, but also the vast aggregate of fruitless labors imposed on those who should be preoccupied with the business of research. In the meantime, while no expansion is permissible under existing income, the current activities of the institution may continue without serious modification of plans or impairment of efficiency.

R. S. Woodward

SCIENTIFIC EVENTS

WIRELESS TELEGRAPH INSTALLATION AT THE UNIVERSITY OF CHICAGO

A notable addition to the equipment of the Ryerson Physical Laboratory at the Univer-

sity of Chicago has recently been made by the installation of wireless telegraph apparatus. The aerial will be stretched between the mast on Ryerson Laboratory and a similar one on Mitchell Tower, making available approximately a height of 140 feet and a length of 425 feet for the aerial conductor. This will consist of eight wires, each made of seven strands, which, including leads into the building, will require nearly six miles of phosphor bronze wire. The mounting and insulation will be most fully provided for in order to withstand a pull of three thousand pounds, which a heavy wind on ice-covered wires might produce; and also to make the electrical leakage negligibly small even when using the 20,000 volts which will be employed in transmission experiments.

The first transmitter will be of five kilowatts capacity, which will be sufficient for the present, though not suitable for transoceanic communication. The important parts of this apparatus are being made in the Ryerson Laboratory and already preliminary tests have shown that a high degree of efficiency will be attained.

All types of receiving instruments will be used and the excellent character of the aerial will make it possible to receive and experiment with the radiations from all the high-powered stations of the United States and with many of those of the European nations. Research work has already been started and arrangements made to carry on work in coöperation with another university as soon as the installation of the Ryerson apparatus is completed. Courses on the theory of wireless telegraphy and telephony coordinated with electrical measurements will be given during the coming summer quarter.

Associate Professor Carl Kinsley, of the department of physics at the University of Chicago, who prepared the substance of the foregoing statement, was for several years an electrical expert for the War Department and devised a wireless system, which was the first to be accepted by the United States government and is now in use by the San Francisco wireless station. Professor Kinsley has been connected with the University of Chicago for fifteen years.

THE LEASE OF THE TROPICAL BOTANICAL STATION AT CINCHONA

The botanical station at Cinchona, in the Blue Mountains of Jamaica, formerly leased for ten years by the New York Botanical Garden, has now been leased by the Smithsonian Institution, on behalf of fourteen American botanists and botanical institutions that have contributed the rental. These botanists and institutions believe there is need in the American tropics of a counterpart of the famous Buitenzorg Garden in Java. They hope the opening of this laboratory at Cinchona may prove as stimulating to the development of botany in this country as the opportunities afforded at Buitenzorg have to the advance of this science in Europe.

The equipment available at the station consists of the residence, with its furnishings; of three laboratory buildings, two glass propagating houses and a garden of ten acres, containing scores of species of exotic shrubs and trees, besides many native plants from the highlands of Jamaica. The occupant of Cinchona is also free, within reasonable bounds, to study and collect plants over the many thousand acres of the whole Cinchona reservation, as well as in the neighboring valleys belonging to private owners. He will likewise be given every available facility for study at Hope Gardens, where he will find a herbarium, a library and an extensive collection of tropical plants. The same privilege will be his at Castleton Garden which contains a splendid collection of cycads, of palms, and of *Ficus* and other dicotyledonous trees.

The many different types of native vegetation accessible from Cinchona and from Hope, include a number of great ecological interest and numerous species of importance for the morphologist, cytologist and physiologist. The ecological types range from the tree ferns, epiphytes and water-soaked filmy ferns of the cool mountain forest to the hot, steaming woods of the lowlands of the north side at one extreme and to the dry savannahs and cactus deserts near Kingston at the other. Fuller

statements of the opportunities for research in various lines, written by men who have worked there, may be found in Science, Vol. 43, p. 917, 1916. (See also *Popular Science Monthly,* January, 1915.)

Any American investigator may be granted the use of the Cinchona Station by the Cinchona Committee, which consists of N. L. Britton, John M. Coulter and Duncan S. Johnson. Applications for this privilege and for information regarding the conditions under which it is granted should be sent to Duncan S. Johnson, Johns Hopkins University, Baltimore, Md.

THE COUNCIL OF NATIONAL DEFENSE

The Council of National Defense and its advisory commission, composed of civilians, have decided to appoint seven committees to further develop the program for the mobilization of the resources of the country. They have issued the following statement:

The program of the council and commission has for its object the provision of an adequate military and naval defense based on an adequate industrial and commercial coordination and preparation. To attain this end, a definite, immediate and continuing program is being worked out.

The commission has divided into committees. A member of the commission is the chairman of each of the committees. Committees have been formed to take charge of the following subjects, and other committees will be formed as they may be needed.

A. Medicine, including general sanitation, Commissioner Franklin H. Martin, chairman.

B. Labor, including conservation of health and welfare of workers, Commissioner Samuel Gompers, chairman.

C. Transportation and communication, Commissioner Daniel Willard, chairman.

D. Science and research, including engineering and education, Commissioner Hollis Godfrey, chairman.

E. Raw materials, minerals and metals, Commissioner Bernard Baruch, chairman.

F. Munitions, manufacturing, including standardization and industrial relations, Commissioner Howard Coffin, chairman.

G. Supplies, including food, clothing, etc., Commissioner Julius Rosenwald, chairman.

The chairman of each committee will call a series of conferences with representatives of trades, businesses or professions. At such conferences the representatives shall be asked to organize so as to deal with the council through one man or through a committee of not more than three men, to whom the council shall submit problems which may affect the national defense and welfare.

One or more members of the council will meet the conferees and set forth the desires of the government and its needs. To quote the words of the enabling act, these needs are "the creation of relations which will render possible in time of need the immediate concentration and utilization of the resources of the nation."

The chairmen were authorized to select committeemen from either government or civil life.

THE ANNUAL MEETING OF THE NATIONAL ACADEMY OF SCIENCES

The annual meeting of the National Academy of Sciences will be held at the Smithsonian Institution in Washington on April 16, 17 and 18, 1917.

By direction of the council and of the program committee, members are invited to present brief announcements, not exceeding ten minutes in length, of new discoveries and of the results of current research work, somewhat similar in scope and character to the announcements regularly made in the Proceedings. Titles, accompanied by an abstract of 100 or 200 words, should be sent to the chairman of the program committee, Professor B. B. Boltwood, Yale University, New Haven, Conn., not later than March 30, in order to be included in the program to be printed in Science. Titles which reach the chairman later than March 30 will be assigned a place by the program committee so far as time permits. About one third of the scientific program has been reserved for these announcements; the remainder will be arranged by the program committee. The sessions will be held as follows:

Monday, April 16

9.30 a.m. Business session, U. S. National Museum.

10.30 a.m. Scientific session (open to the public), U. S. National Museum.

2.30 p.m. Scientific session (open to the public), U. S. National Museum.

4.00 p.m. First William Ellery Hale Lecture,

by Edwin Grant Conklin, professor of zoology, Princeton University. Subject: "Methods and Causes of Organic Evolution" (open to the public), U. S. National Museum.

9.00 P.M. Reception, main hall, Smithsonian Institution.

Tuesday, April 17

9.30 P.M. Business session, U. S. National Museum.

10.30 A.M. Scientific session (open to the public), U. S. National Museum.

2.30 P.M. Scientific session (open to the public), U. S. National Museum.

8.00 P.M. Annual dinner, Raleigh Hotel. Presentation of medals.

Wednesday, April 18

9.30 A.M. Business session, U. S. National Museum. Election of officers and members.

1.30 P.M. Luncheon, Raleigh Hotel.

3.00 P.M. Scientific session (open to the public), U. S. National Museum.

4.00 P.M. Second William Ellery Hale Lecture, by Edwin Grant Conklin, professor of zoology, Princeton University. Subject: "Methods and Causes of Organic Evolution" (open to the public), U. S. National Museum.

SCIENTIFIC NOTES AND NEWS

THE portrait by Henry Ulke of Joseph Henry, first secretary of the Smithsonian Institution, has been transferred by a senate resolution, from the capitol to the Smithsonian Institution, where it has been hung in the National Gallery of Art, in the new building of the National Museum.

DR. WILLIAM H. WELCH was the guest of honor at the tenth annual banquet of the Æsculapian Club, Philadelphia, on February 6.

PROFESSOR AUSTIN F. HAWES, head of the forestry department of the University of Vermont and state forester, has resigned. Two positions were created lately in the United States Government's States Relations Service, foresters in charge of the Agricultural Extension work, one for the Cotton Belt States and one for the states of the north and west, the last of which Professor Hawes will fill.

DR. FABIAN FRANKLIN, associate editor of the New York *Evening Post* since October, 1909, has resigned. Dr. Franklin was professor of mathematics in the Johns Hopkins University from 1879 to 1895.

DR. MORTON G. LLOYD, formerly technical editor of *The Electrical Review* and *Western Electrician,* has accepted a temporary appointment as associate engineer in the Bureau of Standards, Washington, D. C.

K. F. KELLERMAN has been promoted from the position of assistant chief to that of associate chief of the Bureau of Plant Industry, U. S. Department of Agriculture.

DR. WATSON L. WASSON, professor of mental diseases in the college of medicine of the University of Vermont, has accepted the position of superintendent of the Vermont State Hospital for the Insane at Waterbury to succeed Dr. Don D. Grout, who has resigned. Dr. E. A. Stanley has been appointed to succeed Dr. Wasson at the University of Vermont. He has been a member of the hospital staff for some time.

AFTER seven months' absence in Japan, Korea, southern Manchuria and China, Assistant Professor Wellington Downing Jones, of the department of geography at the University of Chicago, has returned to the university for his regular work. The purpose of his trip to the Orient was to get a general view of the regions visited so as to be able to study intelligently what has been written about them, and also to plan effectively future detailed field investigations.

IT is stated in *Nature* that Captain Amundsen, the Norwegian explorer, who proposes to endeavor to reach the North Pole by aeroplane, is on his way to Norway from America to complete his plans. The ship in which he will make the first part of the journey is to be launched at Christiania next March, and Captain Amundsen expects to start his scientific expedition about the summer of next year. He hopes eventually to come in touch with Robert A. Bartlett, another explorer, who is going via Bering Strait.

AT the annual meeting of the Royal Microscopical Society, held on January 17, the following officers were elected for the year 1917: *President,* E. Heron-Allen; *Vice-presidents,* J.

E. Barnard, A. Earland, R. G. Hebb, F. Shillington Scales; *Treasurer,* C. F. Hill; *Secretaries,* J. W. H. Eyre, D. J. Scourfield; *Librarian,* P. E. Radley; *Curator of Instruments,* C. Singer; *Curator of Slides,* E. J. Sheppard; *Editor of Journal,* R. G. Hebb.

Professor Frederic S. Lee, of Columbia University, lectured before the Science Club of the University of Wisconsin on February 12, on "Air and Efficiency."

On February 8 Professor Murlin, of Cornell University, addressed a meeting of the Biological Society of the College of the City of New York on "The Relation of Acidosis to Carbohydrate Metabolism." Professor Abraham J. Goldfarb and Dr. Dayton J. Edwards participated in the discussion following the lecture.

Professor William K. Gregory, of Columbia University and the American Museum of Natural History, delivered an illustrated lecture before the Biological Society of the College of the City of New York on "The Evolution of the Human Race," on March 1.

Nearly $400,000 was bequeathed in 1910 to the city of Munich by Dr. G. Krauss to found, as a memorial to his father, an institution for mechanical and other forms of orthopedics, especially those practised by the elder Krauss. The building is now completed. It stands on the grounds of the university orthopedic clinic with which it is closely affiliated, Professor F. Lange being in charge.

Edward Dyer Peters, Gordon McKay professor of metallurgy, Harvard University, died on February 17, in the sixty-eighth year of his age.

C. Owen Waterhouse, formerly assistant keeper of the British Museum of Natural History, died on February 4, at the age of seventy-three years.

The death is announced of J. M. Alvarez, professor of hygiene at the University of Cordoba, Argentina, senator of the realm and governor of the Province of Cordoba, aged fifty-seven years.

The death at the age of fifty-four years is announced of Dr. H. Schulthess, of Zurich, known for his work on heart diseases, the sphygmometer and photography of the pulse.

M. Honnorat, deputy of the department of the Lower Alps, is said by the *Journal of the American Medical Association* to have ready for publication the demographic statistics of France for 1915. The data at hand are as follows:

Years	Births	Deaths
1913 (77 departments)	604,454	588,809
1914 (77 departments)	594,222	647,549
1915 (76 departments)	382,466	644,301

Therefore, in the departments which can be accounted for, registry shows: in 1913, an excess of 15,645 births; in 1914, an excess of 53,327 deaths, and in 1915, an excess of 261,835 deaths. The figures do not represent correctly the births and deaths in the invaded departments in the war zone, where almost all the deaths of combatants are registered.

The Imperial Russian Society of Mineralogy celebrated its centenary in January. Owing to existing circumstances, a special session was not held, but there was a general meeting and an exhibit showing the history of the society.

At the two hundred and twenty-eighth meeting of the Elisha Mitchell Scientific Society at the University of North Carolina on February 20, Mr. Collier Cobb spoke on "Recent Changes in Currituck Sound," and Mr. Horace Williams on "The Philosophy of Science."

The second annual Drainage Conference of the University of Illinois is to be held March 13–15, 1917. Engineers, drainage officials, contractors, public officials, land-owners and business men from all parts of the state will be in attendance to consider such subjects as the reclamation of swamp and overflowed lands, flood control and the conservation of the soil. The subject of land reclamation in Illinois is one of greater importance than is generally supposed. Although some three million acres of uplands have been drained, there remain great overflow areas of rich lowlands along the rivers, the aggregate extent of which is greater than that of Holland and the reclamation of which would add $150,000,000 to the land values of the state. The conference to be held at Urbana will have for its purpose the

stimulation of greater interest in this problem. The speakers will be engineers and public officials of prominence and information regarding the practical phases of drainage will be made available to those in attendance. The organization and financing of drainage districts, the surveying of drainage areas, the design of systems and improved methods of construction are among the subjects to be considered. The meeting will be in charge of the department of civil engineering, college of engineering, Urbana, Illinois.

"ASPECTS of Modern Science" is the general subject of a series of lectures being given by members of the faculties of the University of Chicago, at the North Side Center of the University Lecture Association of Chicago. The series was opened on February 19 by Professor Robert A. Millikan, of the department of physics, who spoke on "Modern Views of Electricity." On the evening of February 26, Associate Professor William Draper Harkins, of the department of chemistry, discussed the subject of "Radium, the Breaking Up of Atoms, and the Evolution of the Elements." On March 5, Professor John Merle Coulter, head of the department of botany, will lecture on "The Revolution in Agriculture," showing how the investigations of heredity and of the soil have revolutionized agricultural practise and bid fair to solve the pressing problem of food production. On March 12, Associate Professor Walter Sheldon Tower, of the department of geography, will discuss "The Meaning of Modern Geography," and, on March 19, Director Edwin Brant Frost, of the Yerkes Observatory, will present some of the "Revelations of the Spectroscope." The closing lecture, "The New Geology," on March 26, will be given by Dean Rollin D. Salisbury, of the Ogden Graduate School of Science, who will present some of the newer theories concerning the earth's history, especially its origin and its age.

UNIVERSITY AND EDUCATIONAL NEWS

PRESIDENT WILSON signed, on February 23, the Smith-Hughes Vocational Education Bill, which provides large funds for federal aid to the states for the teaching of agriculture, trade, industries and home economics.

MR. AND MRS. MAX EPSTEIN, of Chicago, have contributed to the medical school enterprise of the University of Chicago $100,000 to erect and furnish the equipment for a university dispensary. This will provide a structure in which will be reception rooms, rooms for diagnosis and treatment, rooms for hospital and dispensary social service work and workers both professional and volunteer.

MR. FRANK G. LOGAN, of Chicago, has given to the University of Chicago a fund providing an income of $3,000 a year for three research fellowships, one in pathology and bacteriology, one in medicine and one in surgery.

AT a recent meeting of the faculty of the Long Island College Hospital it was voted to admit women students on the same terms as men.

IT is stated in *Nature* that Mr. E. J. C. Rennie, son of Professor Rennie, of the University of Adelaide, has been appointed acting lecturer in electrical engineering in the University of Melbourne. He will take the place of Mr. E. B. Brown, who is about to engage in munition work in England.

DR. C. E. MOSS, of the University of Cambridge, has been appointed professor of botany in the South African School of Mines and Technology, Johannesburg.

DISCUSSION AND CORRESPONDENCE

PHOSPHATE EXPERIMENTS

IN SCIENCE, January 5, 1917, pages 18 and 19, Professor C. A. Mooers writes as follows concerning the results of Tennessee experiments with different phosphates:

> Neither now nor in the past have these results allowed us to advocate, as intimated by Dr. Hopkins, the use of unacidulated bone meal. From the standpoint of economy, the data obtained here have been decidedly in favor of acid phosphate. In Dr. Hopkins's article omission was made of the fact that in the table referred to—Bulletin 90, p. 89, Tennessee Agricultural Experiment Station—every $1.00 invested in acid phosphate gave on the average a calculated profit of $4.28 where the

cowpea crops were turned under, and of $5.42 where they were removed for hay. Phosphate rock, on the other hand, gave by a similar calculation a profit of only $2.58 where the cowpea crops were turned under and the same amount where they were removed for hay.

On pages 87 and 88 of the Tennessee bulletin, No. 90, Professor Mooers makes the following statements:

The steamed bone meal, although included among the relatively insoluble phosphates, appears in these experiments to occupy an intermediate place, with returns little inferior to those from acid phosphate. As compared with phosphate rock the mechanical condition of the meal is in its favor; also its content of organic matter is supposed to assist in its decomposition. But in these experiments the influence of the nitrogen contained in the meal must not be overlooked and probably gives it a higher standing than can be attributed to the phosphoric acid alone. Evidently it is a valuable fertilizer for soils like these, and the confidence placed in it by many farmers of the Highland Rim and other parts of the state seems not to have been misplaced.

The calculated profits mentioned in Professor Mooers's SCIENCE article are evidently based upon different valuations than those reported in the bulletin, as may be seen from the following table taken from page 89 of the bulletin:

RESULTS OF TENNESSEE EXPERIMENTS

Cowpea Crops Turned Under

Phosphates Used			Calculated Profit	
	Amount	Cost	Unlimed	Limed
Acid phosphate..	229 lb.	$1.83	$3.37	$4.47
Bone meal........	218 "	3.27	3.13	2.73
Phosphate rock..	383 "	1.53	2.57	1.37
Cowpea Crops Removed				
Acid phosphate..	261 lb.	$2.09	$5.34	$5.98
Phosphate rock.	385 "	1.54	4.73	−0.77

Easy computations show profits per $1.00 invested of $0.90 from bone meal and $1.29 from phosphate rock, as an average of the comparable figures.

On page 90 of the Tennessee bulletin Professor Mooers makes the following statement:

There seems, therefore, to be little promise in phosphate rock on soils like those under consideration, unless liming be omitted, and even then the results of Series III. and IV. show that acid phosphate may be much more profitable than the untreated rock.

Computation from the figures in the accompanying table show average profits from the unlimed land of $2.20 from acid phosphate and $2.38 from raw rock phosphate, for every $1.00 invested.

When we consider (1) that wheat was grown every year upon the same land in these Tennessee experiments; (2) that 70 per cent. of the phosphorus in the raw phosphate applied will remain in the soil for the benefit of future crops after the acid phosphate is exhausted; (3) that raw rock phosphate is now procurable in very much better mechanical condition than when these experiments were conducted; (4) that, as an average of sixteen years at Wooster and nineteen years at Strongsville, Ohio,[1] the increase in crop values were $4.01 from nonacidulated bone meal and $3.78 from acidulated bone black, on adjoining plots in a five-crop rotation system, providing for every crop every year; and (5) that, as an average of results from twenty years of investigation by the Rhode Island Experiment Station,[2] better returns per $1.00 invested were secured on both limed and unlimed land from both raw rock phosphate and ground bone than from any one of four different acidulated phosphates; then we find still more difficulty in harmonizing all expressed opinions with the established facts.

CYRIL G. HOPKINS

UNIVERSITY OF ILLINOIS

THE ORGANIZATION MANIA

TO THE EDITOR OF SCIENCE: It is to be hoped that the Report of the Subcommittee on Research in Industrial Laboratories, published in SCIENCE for January 12, marks the high water mark of the organization mania now sweeping the country. The research worker must have an assortment of extraordinary qualifications.

1 Ohio Experiment Station Circulars 104 (p. 11) and 144 (p. 97).

2 Rhode Island Experiment Station Bulletin 163, p. 547.

Nothing is said, however, of what rewards, either financial or social, are for him. Apparently he should be willing to be a cog in a machine in an institution. It is difficult, says the Report, to locate "a skilled private assistant—one who possesses not only originality, but also sound judgment and intellectual honesty." If you add to these qualifications a handsome appearance, you will have nearly the perfect man—and then you offer him the glorious position of private assistant. Happily, however, he will not be foolish enough to take it. He will make more money, have more independence, and win more social esteem if he devotes his originality to writing "compelling" soap advertisements. He will also have an infinitely easier life.

The amazing statement is made that "the individual can exert only a very small influence except as a member of an organization." One wonders what institution or organization Newton or Darwin belonged to, without which "they would have exerted only a very small influence." Coming nearer home, to what institution does Mr. Baekeland or Mr. Elihu Thomson belong?

The best possible thing that executives can do for science is to efface themselves as much as possible. Thank heaven, the "centralizers and coordinators" (as Sir Ronald Ross calls them) did not get hold of Dalton or Faraday or even Shakespeare, for creative originality is the same, substantially, to whatever it may be applied. Not only do executives often absorb salaries that ought to be paid to research workers, but they create a public impression that the workers are their subordinates, as if a scientific worker were an inferior sort of animal who needed some one to coordinate his activities.

Executives also absorb some of the most stimulating parts of the work—the planning and prominent public expression. Worst of all, they operate to deprive a scientific worker of that independent position which is the life blood of a man of original and vigorous habit of mind. The proper model of the scientist is the judge. The lack of independent position surely drives many away from fruitful work. The writer knows two men of scientific training and of vigorous and original minds who went into the advertising business. Needless to say, they are earning vastly more, and are enjoying a far more independent position, than the majority of scientific workers. No executive tells them to "cooperate." They cooperate or not, just as they see fit.

Of course cooperation comes in strong in the report, even if it works to deprive talent of its just rewards. Originality is not joint but personal. An army wins a battle, but the creative thinking is commonly done by some one Napoleon. The writer knows of a case recently where an organization worked on a problem for many months without achieving anything except more or less useful (mostly trivial) data. But one day a member not working on that problem, devoted some high tension thinking to the subject, aided by a happy combination of other knowledge, and was able to see the solution of the whole question on radically different lines. If he had turned in his contribution, he would have received only minor recognition, as he had spent only a short time on it. As it was, he kept it to himself and is now reaping a legitimate reward. How could his inventive originality be asked to divide the credit and rewards with mere data collecting—for the two things are not commensurate? To use a current expression, they are "not in the same class." And yet he should not be secretive, *i. e.*, talent should give its ideas to mediocrity. There are kinds of cooperation where one eats the dinner, and the other pays the check and tips the waiter and cloak room girl besides.

Other scientists would do well to take a leaf from the surgeon's book. Certainly in part, the high position of American surgery is owing to the fact that the surgeon's work is his own. I presume that the Mayo brothers have an "executive," precisely as any hospital has a manager, who attends to the buying of supplies, etc., but nobody ever heard of him. It is curious how American surgeons have been able to do such good work with no "executive surgeons" to occupy the center of the stage, and make them cooperate. Incredible as it may

seem, in this field the mahogany roll-top desk is not the greatest thing in the world.

Says Professor Fite in the *Nation:*

> Wherever two or three are gathered together, and even where they are not gathered together, some one is on his way to organize them. In the madness for organization we have long since lost sight of the end in the means; we have forgotten that neither the fruition nor the advancement of human life can take place in the absence of individual freedom and creativeness, and we have come to believe that the sole meaning of life and of culture is—to be organized.

INDIVIDUAL

SCIENCE AS CONTRABAND

TO THE EDITOR OF SCIENCE: Through the kind offices of Professor James Ward the British authorities have consented to release the books sent from Germany to the *Psychological Review*. The Psychological Review Company desires to express its thanks to Professor Ward.

For the benefit of other scientists who may be similarly involved it should be stated that the action taken was a pure act of courtesy to Professor Ward. The taint of contraband still infects scientific literature in the opinion of the procurator general; but he is willing to defer to expert judgment.

HOWARD C. WARREN

PSYCHOLOGICAL REVIEW CO.,
PRINCETON, N. J.,
February 20, 1917

TRIMMED MAGAZINES AND EFFICIENCY EXPERTS

TO THE EDITOR OF SCIENCE: Your correspondent "H. P." waxes somewhat warm in your issue of January 12 on the above subject and evidently prefers his untrimmed. To me it seems "all nonsense" to say that "I have always found that I got more out of an unopened magazine than an opened one." The contents are of course the same in either case, the difference is in one's mental attitude. I find my weekly copy of SCIENCE so interesting that I almost invariably read it clear through, and I do not want to be delayed in getting at its contents by having to cut its pages. I find it very irritating to have to cut the pages of an interesting book when I had much rather be reading it. Such work is to me a waste of time and energy. SCIENCE is read weekly by some 12,000 to 15,000 busy men and women whose time is valuable in the literal as well as in the figurative sense, hence the "general opinion that the copies should be trimmed." This suits the present writer, but it is to be regretted that "H. P." can no longer get his untrimmed.

E. W. GUDGER

STATE NORMAL COLLEGE,
GREENSBORO, N. C.,
February 1, 1917

QUOTATIONS

INTELLECT AND THE WAR

HAD not experience amply shown that no subject is so remote as to make it exempt from contact with the workings of the great war, one might expect such immunity in the case of a paper on "The Relations of Mathematics to the Natural Sciences." As it is, one is not in the least surprised to find that the bearing of the present state of the world on the future of mathematical research is the theme of the closing remarks in the presidential address with that title delivered at the recent meeting of the American Mathematical Society by Professor E. W. Brown, the distinguished mathematical astronomer of Yale. While the stupendous events of the past two years have caused the need for scientific research to be emphasized more strongly than ever before, he says, yet it is to be remembered that in this the practical end alone is contemplated, and the purely intellectual side is little regarded. "The future of research in pure science is in danger as never before," he warns.

For this fear there is only too much ground, though in our judgment it would be a deplorable error to accept as inevitable that which is only threatened. No man can say what reaction there may be after the war from that state of mind which the appalling demands of such a conflict as is now convulsing the world inevitably produce. Everything depends on the nature of the peace which is to follow. If it is to be such as will compel a

state of gigantic preparedness for a renewal of the stupendous struggle, the constant expenditure and strain directly involved will be no more certain than such consequences in the domain of the intellect as Professor Brown foreshadows, and as other men concerned for the future of intellectual aspiration have undoubtedly been apprehending. If, on the other hand, the world shall be blest with such an outlook at the close of the war as will make the recurrence of such a calamity seem practically out of the question, it is by no means impossible that release from the fearful strain of the war will carry with it a spontaneous rush of lofty minds into regions as remote as possible from that into which the life of man had been so inexorably forced during the years of terror. To trust to any analogy of the past, when the present is in some vital respects so utterly without precedent, would be most unsafe; yet it is not without significance that in this very domain of pure mathematics two periods of the highest fecundity have occurred precisely when it might have been supposed that the minds of men were completely absorbed in the tremendous actualities of war. During and for some years after the wars of the First Republic and of Napoleon, there was in France such a flowering of mathematical genius and such splendor of mathematical achievement as have hardly been matched in the history of the world; and it was immediately after the war of 1870 that, after a long period of comparative quiescence, that same spirit flashed out in the brilliant group of mathematicians of whom Henri Poincaré was but one, though the most illustrious, exemplar.

However this may be, there can be no doubt that the gospel of relentless "efficiency" to which the war has given so great an impetus carries, deeply embedded in it, the seeds of hostility to all activities and interests which find their spring in intellectual aspiration or enthusiasm. At best, from the standpoint of the efficiency cult, such endeavors have to be justified by the plea that, divorced as they may seem to be from practical objects, they do conduce to the advancement of the common ends of the nation or of mankind, though the connection may be remote or subtle. The plea can be made good over a very broad area, and in the case of mathematics the constant interplay between the advancement of pure theory and the pursuit of its physical applications makes the task easier than in many other cases. But the argument is a thorny one; and that is not the worst of it. The mere necessity of resorting to such a defensive plea, the mere surrender of the proud conviction that the pursuit of truth is in itself a noble end which requires no secondary justification, must immeasurably depress the tone of scientific enthusiasm and impair the energy with which its objects are pursued.

And it has to be confessed that, long before the war began, long before any shadow of its approach had been cast upon the world, another factor was working powerfully toward the production of the same effect. For years, and most of all in this country, the idea that "service" is the only justifiable motive of intellectual endeavor had been steadily gaining ground. It is true that occasion has shown, again and again, that the intellectual world had not been swept from its moorings; that, as usual, the latest mode had been taken up by persons whose vocal facility produced a false impression both of their numbers and their weight. Nevertheless, the trend was marked enough to be important; and, unless checked by staunch self-assertion on the part of those whose convictions were deeper, as well as more informed, it threatened grave injury to one of the highest interests of civilized mankind. With the reinforcement which the developments of the war have from so different a quarter brought to this tendency, it is more than ever necessary for those to assert themselves who know how precious to the life of us all is that element which is supplied by the devotion of the lives of some to the pursuit of truth for its own sake, or even for the sake of the fame which is the natural reward of signal success. John Milton had perhaps as high an ideal of service as the youngest of our present-day reformers; yet it was not with contempt that he spoke of those who "scorn delights and live laborious days" in the pur-

suit of intellectual fame; nor did Newton do less for the greatness of his country, from whatever standpoint you choose to view it, by uncovering the secret of the universe than he would have done by sticking closer to earth in the strivings of his unrivalled intellect.—New York *Evening Post.*

SCIENTIFIC BOOKS

An Introduction to Historical Geology with Special Reference to North America. By WILLIAM J. MILLER. New York: D. Van Nostrand Company. With 238 illustrations. Pp. xvi + 399. $2.00 net.

The meaning of the word geology was greatly modified and vastly expanded in the early part of last century through the works of Wm. Smith, Cuvier, Brongniart and their followers. In the place of philosophical mineralogy the meat and marrow of the subject became earth history. To this phase of the subject Conybeare and Phillips devoted the greater portion of space in their well-known treatise of 1822. Lyell's tastes being largely along the line of the modern physical geographers, judiciously termed his great work not Geology, but the "Principles of Geology, or the modern Changes of the Earth and Its Inhabitants Considered as Illustrative of Geology." Yet he included in the earlier five editions of this work a large amount of stratigraphical matter gleaned during his various trips into the Tertiary fields of south Europe. In 1838, however, he excerpted the stratigraphical or historical matter from his "Principles," recast and enlarged upon the same and brought out a separate volume called "Elements of Geology." This ran through some half-dozen editions down into the "seventies" and was referred to by him as Elements of Geology, Students' Elements of Geology, Geology Proper or simply Geology. Some time before, however, De la Beche had foreseen the divisibility of the subject along similar lines, for he remarks in the preface to his treatise of 1833:

It is not difficult to foresee that this science, essentially one of observation, instead of being, as formerly, loaded with ingenious speculations, will be divided into different branches each investigated by those whose particular acquirements may render them most competent to do so; the various combinations of inorganic matter being examined by the Natural Philosopher, while the Natural Historian will find ample occupation in the remains of the various animals and vegetables which have lived at the different periods on the surface of the earth.

A recent text-book of geology, by Pirsson and Schuchert follows practically the lines of subdivision suggested by De la Beche: Part I. is designated Physical Geology; Part II., Historical Geology. These parts may be purchased in separate binding. Another recent text-book by Cleland, is styled "Geology, Physical and Historical."

In Miller's work before us we have an independent volume styled "An Introduction to Historical Geology." This the author hopes "may find a place as a class-book dealing with the historical portion of a one-year course in general geology," adding, however, "An elementary knowledge of what is generally comprised under dynamical and structural geology is presupposed."

Except in this independent character of the work, Professor Miller's production does not differ radically from what has usually been found in the historical portion of the better text-books on geology. That is, the various periods are taken up in chronologic order. The origin of the name of the period, its subdivisions, distribution of rocks, physical history, foreign equivalents, climate, economic products, and life are the usual subdivisional topics. Under life, Plants, Protozoa, Porifera, Cœlenterata, Echinoderms, Molluscoids, Mollusca, Arthropods and Vertebrates, with subdivisions are systematically discussed. The author quotes freely from modern text-books, manuals and general geological literature, seemingly content to let well-enough alone. Likewise "appropriate illustrations more or less familiar because of their appearance in other text-books or manuals of geology, have not been abandoned merely for the sake of something new or different."

As regards the matter of allotment of space and attention to the several eras, we believe good judgment has been shown. 145 pages are

devoted to the Paleozoic; 80 to the Mesozoic; 100 to the Cenozoic. This is in pleasing contrast to what is seen in several recent works where an overweening preponderance is given to the Paleozoic, apparently because it was long! or, because the author's interests were largely in that era. To be sure some phases of the Mesozoic are ill represented in this country, and, in preparing a work for American students a less complete account of this era is permissible; but not so with the Cenozoic so grandly recorded throughout the length and breadth of this land. And again, in this era were evolved the teeming hordes of modern life on land, in sea and air, life of most fundamental interest to man, and man himself. Imagine a work on general history descanting on ancient civilizations, because they extended through vast periods of time! commenting more briefly on medieval epochs, and brushing aside with a few paragraphs the fundamentally important, profoundly intricate and comparatively accessible developments of modern history. The writer on historic geology has, however, greater difficulties before him than the assignment of space to eras. Above all comes the Herculean task of vividly portraying to the beginner the events of earth history by means of legitimate deductions drawn from fossil forms, all of which are unknown to the student. Whoever has listened to a lecture on a new subject in a strange tongue will appreciate the difficulty here referred to. The average American youth may listen profitably to a discourse on mountains, rivers, oceans, even perhaps on volcanoes and earthquakes. With animal and plant life in the form of horses, cattle, trees and grasses he is more or less familiar; but, in definite knowledge regarding the life of the sea—the very type the teacher wants to deal with most frequently—he is found wanting. We recall the startled look when he hears the common word Brachiopoda for the first time; we still respect the brilliancy of the student who mnemonically cinched *Tropidoleptus carinatus* not by its biological affinities but by the similarity of its specific name to "Carrie Nation." Professor Miller, like Dana and others, has recognized this general lack of biological preparation on the part of his readers and has devoted an introductory chapter to an outline classification of the animal and plant kingdoms. Thereafter, in orderly review, he gives under each period what is happening among the Echinoderms, Worms, Molluscoids, Molluscs, etc., etc. Now this orderly, card-index style of arrangement of facts is excellent in a book for reference only; but, the bringing up of each little branch of life again and again when not characteristically developed leads necessarily to the introduction of considerable unimportant matter; for example: "The Pelecypods and Gasteropods were still common, but they were in no important way different from those of the preceding period." Or: "Sponges were common but they require no special description."

It seems to the reviewer that such data might be confined to the excellent "Tabular Summary" at the close of each era. The question arises here, as in reference to the majority of texts on historic geology, would it not be better for the student's mental digestion, so to speak, if in place of this menu of a vast number of short-order courses a few well-balanced rations of carefully selected matter were served. Schuchert in the textbook already referred to has apparently acted upon this principle, interlarding his chapters on physical history of the periods with substantial essays on a few dominant types of life characteristic of each great geological period. Time will determine whether the student profits more by being continually reminded of the progress of the various minor subdivisions of life, or, by receiving once and for all a thoroughgoing discussion of a few great, dominant life-forms.

Professor Miller's book seems remarkably free from the small, yet sometimes ludicrous, mistakes that often appear in first editions. Quite probably, however, he will change the wording in the following sentences somewhat in the next edition of the work: (Page 106) "Conformably above the Clinton beds lies the Niagara limestone, which has a still wider distribution than the Clinton."

(Page 136) "All known Devonian vertebrates were aquatic."

(Page 321) "During the Pliocene and Quaternary, *Equus*, or the modern Horse, has one toe only on front and hind feet with the two side toes of *Protohippus* reduced to splints (the fetlock of the present day Horse)."

(Page 305) "In this vastly expanded interior sea true marine deposition took place, the most characteristic formation being a Nummulitic limestone, so called because it is chiefly made up of shells of a certain species (*Nummulites*) of unusually large Foraminifers. Perhaps no other single formation in the crust of the earth built up essentially of the remains of but one species of organism is so widespread and thick, its thickness at times reaching several thousand feet."

(Page 334) "At no time did the Labradorian ice sheet spread enough eastward or the Kewatin sheet far enough westward, to cover this driftless area."

Typographical errors in this book are rare. We now recall having noted but two, one in the caption of page 193, the other in the spelling of the specific name *choctavensis*, page 315.

The illustrations upon the whole are good. The printing of whole-page half-tone engravings on the class of paper used in the text (though very good) is scarcely to be recommended, as the plate on 129 clearly shows. The routing on the line engraving, Fig. 69, page 126, was carelessly done. Slight stains, perhaps from the paste used in securing the illustrations appear about their borders, in Fig. 52, page 95.

The printing is of uniformly good grade, the body type approaching very closely the 10-point modern Lining Roman No. 510 opened up by two point leading, giving always a clear, pleasing appearance. The paper, very slightly reddish tinted, is about 70 lb. book, scarcely shiny, but sufficiently calendered to take small half-tone engravings to advantage.

To sum up: Professor Miller has carefully compiled from recognized authorities facts and figures illustrative of historical geology as now generally understood. He is no iconoclast. He has apparently felt the need of a systematic tabulation of topics, serving as a ground-work for a series of lectures in historic geology. This with minor expansions and articulations forms the text-book before us. What were his needs are likewise the needs of other teachers of the same subject; and, since he has done his work well and his publishers have cooperated with good judgment and artistic ability, there would seem to be no reason why the book should not meet with deserved success.

G. D. HARRIS

PALEONTOLOGICAL LABORATORY,
CORNELL UNIVERSITY

SPECIAL ARTICLES

BOILING BUFFALO CLOVER SEED

THE discovery that the process of boiling the seed of spotted bur clover (*Medicago arabica*) one minute insures good germination has resulted in the adoption of the practise by the farmers of the south. The kindred discovery recently made by the writer that the seed of buffalo clover (*Trifolium reflexum*) can be readily germinated in the same manner, opens the way for experiment station men to investigate the economic merits of this little-known clover. Experiments heretofore attempted have been nipped in the bud, as far as is known, by failure to obtain a stand. With the practise of soaking and boiling, however, stands can be obtained and the merits and demerits of this legume can be found out.

In 1914, after successfully germinating spotted bur clover seed by the boiling process, the same method was tried by the writer on red clover, white clover, sweet clover and alfalfa, but with negative results. A single experiment with buffalo clover at that time increased the germination from four to thirty per cent. by boiling one minute, but this was considered too small a per cent. and the matter was dropped. Recently, however, the experiment was tried again in a slightly modified form and with excellent results.

The details of the experiment were as follows:

Treatment	Per Cent. Germination
None	0
Boiled 5 seconds	53
Boiled 30 seconds	60
Boiled 60 seconds	60
Soaked in cold water 12 hours	0
Soaked in cold water 12 hours and boiled 5 seconds	47
Soaked in cold water 12 hours and boiled 30 seconds	87
Soaked in cold water 12 hours and boiled 60 seconds	93

Buffalo clover is scattered over many states as a wild plant, but is cultivated nowhere. It somewhat resembles red clover in general appearance and habit of growth, but is smaller. Its leaves are narrower and more sharply pointed and its head, when dead ripe, turns over and hangs down like the heads of white clover. It is large enough to have value if it has other desirable qualities.

The writer obtained the idea of soaking the seed before boiling from similar experiments with bur clover by the Alabama Experiment Station. The fundamental experiment of boiling the seed of both species was original, however, with the writer. A. D. McNAIR

GOLDFISH AS EMBRYOLOGICAL MATERIAL

FEW laboratories have at their disposal a constant supply of material for the study of living embryology. Frog and snail eggs are used occasionally, but the supply is uncertain and sometimes difficult to obtain in the right stages, and furthermore, these ova are not particularly favorable for study. While engaged in an investigation on the genetics of goldfish the availability of the eggs of this animal for studies on the living embryo became evident and led to this note.

Goldfish are readily obtained in almost every locality and are thoroughly normal in environments in which few wild fish could exist. They breed in tanks containing not more than fifteen or twenty gallons of water and consequently require no elaborate or extensive equipment. Cypress boxes a foot or more square and three feet long make excellent breeding tanks.

A half dozen pairs or less will supply ample material for class use. It is not necessary to have as many males as females. It is well to obtain fish at least four or more inches long, as the larger fish are more certain to mate and are much more prolific. It is impossible to distinguish the sexes except as the breeding season approaches, when the sides of the female become distended through the growth of the ovaries and small spiny projections appear on the operculum and the anterior edge of the pectoral fins of the male.

One or two months before the breeding season begins it is advisable to feed the adults small quantities of beef, liver, mosquito larvæ or worms several times a week, which strengthens the fish and often advances the mating season. If the fish have been properly fed in the fall, spawning may begin as early as January or February if the aquarium is in a fairly warm place, although I have seldom obtained eggs before March or April.

During the season goldfish spawn at intervals of two weeks or longer and experienced breeders say that large vigorous females may breed as frequently as eight times during the spring, though in my work four or five matings have been more usual. The number of eggs spawned ranges from a few hundred to several thousand at a period, depending on the size of the female, and consequently the season's production, even allowing for unfertilized ova, is very great.

Goldfish spawn in the morning for periods varying from two to eight hours. The female discharges a small quantity of eggs against some water plant and the male, who is at her side at the time, fertilizes the eggs in the water. The feathery roots of the water hyacinth seem to be preferred, although the water plants, myriophyllum and cobomba are very satisfactory. The eggs adhere to the plants and may be removed on them. When it is desirable to time the fertilization accurately the plants may be removed as fast as the ova are discharged against them and others substituted. Though the eggs may be removed from the thread-like leaves or roots of the water plants generally these threads do not interfere and make a convenient handle for moving and

orienting. The unfertilized ova become milky and opaque within twenty-four hours.

Stripping these fish is not entirely successful, as the eggs are so sticky that they clump together and adhere to the fingers of the operator or to anything else they may touch. Moreover, it is difficult to obtain sufficient sperm for a large number of eggs by stripping the male. It is perfectly possible, however, to obtain a few eggs from the female in this way and enough sperm to enable the process of fertilization to be studied under the microscope. Attempts to strip should only be made on those fish which are actually beginning to spawn, when the eggs will flow freely. At this time there is little danger of injuring the female. It is usually possible to determine at least twenty-four hours before the act begins which female is ready to spawn, as the males will follow or chase her about the tank.

The eggs take from two days to a week or more to hatch, depending on the temperature. The ova are perfectly transparent and the developing embryo is easily visible under the binocular.

Further directions for breeding that may be desired can be found in the books of Smith[1] and Wolf.[2]

ROBERT T. HANCE

UNIVERSITY OF PENNSYLVANIA

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION M—AGRICULTURE

ON account of the unusual number of bodies meeting at New York during convocation week whose field borders on agriculture, the Section of Agriculture held only a single session. This occurred Wednesday afternoon, December 27, 1916, in Brinckerhoff Theater, Barnard College, Columbia University, and was presided over by Dr. W. H. Jordan, of the New York Experiment Station. In the absence of the retiring vice-president, Dean E. Davenport, of Illinois, who was unable to reach the meeting on account of delayed train service, it was necessary to dispense with the vice-presidential address. This address was entitled "The Outlook for Agricultural Science" and has been published in this journal.[1]

The feature of the session was a symposium on "The Adjustment of Science to Practise in Agriculture," participated in by Dr. H. J. Wheeler, of Boston, Dr. J. G. Lipman, director of the New Jersey Experiment Stations, Dr. G. F. Warren, of the College of Agriculture at Cornell University, and Director B. Youngblood, of the Texas Experiment Station. Approaching the subject from different angles, the speakers brought out the many important considerations which affect the adjustment and determine the extent of the application of the teachings of science in agricultural practise.

Discussing "Some Factors lying between Scientific Results and the Farm," Dr. Wheeler laid down the proposition that true science is always in accord with the best practise; there is no antagonism between science and good practise, although political, economic and other factors may intervene to modify the extent to which the findings of science are profitable or directly applicable. The prosperity of the farmer is a prime requisite to the application of science in his business. The element of risk is unusually large in farming, and uncertainty as to the character of the season and the price of his products often makes the farmer of limited means hesitate to introduce changes suggested by science. A favorable tariff has in some countries been a large factor in creating conditions under which science can be profitably applied, together with a larger element of stability of the industry.

It was held that agriculture must be stimulated by political action; if the industry is depressed so that the farmers are not making money, science can not lend an effective helping hand to the art. The encouragement of private ownership of land, the adjustment of the farm to the farmer's capacity, and adjustment of the farming system so as to distribute and give employment to the labor throughout the year, are all important as determining factors lying between knowledge and its utilization on the farm. The condition of the land as, for example, the need of drainage, may be another factor in realizing advantages from the application of scientific principles. Illustrations were drawn from German agriculture to show how favorable conditions have been a means of developing agriculture and of putting into practise the teachings of the experiment stations and other educational agencies. As an example, the use of fertilizers was

[1] Smith, Hugh M., 1909, "Japanese Goldfish," W. F. Roberts Company, Washington.

[2] Wolf, Herman T., 1908, "Goldfish Breeds and Other Aquarium Fish," Innes and Sons, Philadelphia.

[1] SCIENCE, N. S., Vol. XLV., p. 149.

cited, which represents the application of science in determining the fertilizer needs and of education in their intelligent use.

Emphasis was laid on the importance of the true interpretation of science in practise, and attention was called to some of the factors which may upset the laboratory results and conclusions when they come to be applied. Hence broad generalizations from laboratory experiments under artificial conditions are to be made with great care. It is necessary to know not only the exact conditions under which the experiments were made, but the modifying character of various factors occurring in nature. The present confidence of the farmers in scientific work and their readiness to adopt suggestions makes it highly important that the teachings be sound from both a scientific and a practical standpoint.

In regard to "The Limitations of Science to Progress in Agriculture," Dr. Lipman mentioned first of all those inherent in investigators, which necessarily have the effect of retarding progress in acquiring knowledge and applying it in the field of agriculture. While contending that science itself knows no limitations, he agreed that there are many important phases of agricultural questions which have as yet eluded science because of the limitation to human ingenuity and ability to discover. Lack of vision is a most frequent deficiency; the outlook needs to be broadened as the problems become more intricate and technical. There needs also to be a quite thorough understanding of farm problems and of conditions surrounding the industry, so that the findings of science may be properly related to practise and practise may thereby be made scientific. Dr. Lipman strongly urged the adequate preparation of men for research in this field.

But apart from this, the greatest limitation of science in agriculture at present is in its application. This is due quite largely to lack of education of the average farmer. The man power is the real measure of efficiency of production, rather than the acre, and the increase of this measure means more education. To raise the level of production there must be a higher level of education among the mass of farmers. Economic conditions constitute another type of limitation in this connection. The scientific facts may be known beyond doubt, but owing to conditions the employment of these may for the time being be impractical and uneconomic.

Lack of working capital was mentioned as another very serious limitation to the application of science, which often hinders raising the level of production; and the same is true of lack of cooperation among producers, because single-handed the American farmer is often not able to fully utilize the findings of science or to take advantage of them as he might if broader areas and larger interests were concerned.

In considering "Economic Factors affecting the Application of Science to Agriculture," Dr. Warren maintained that when the attempt is made to apply the principles of natural science to industry no method is scientific that fails to count the cost. Because scientists sometimes fail to take full account of the economic aspects of agricultural problems, farmers criticize them as theorists, and because farmers refuse to follow their teachings scientists often criticize them for being unprogressive. It was held that while there is opportunity for improvement in agriculture as in all of the industries, "the erroneous but well-nigh universal idea of the city that science can easily double agricultural production leads to the most unfortunate public policies."

The effects of transportation, distance from market and special local conditions, were considered. Products which are easily and cheaply shipped may be produced long distances from market, while perishable products and those that are bulky are advantageously produced near market. For this reason the eastern dairyman is warranted in growing his hay and buying most of his grain, shipping his milk and butter to nearby cities. New York state is suited by climate and soil to the growth of sugar beets and efforts have been made to establish the industry there, but sugar can be shipped long distances, and near market it can not compete with bulky products, such as cabbages, potatoes and hay. Furthermore, it is not enough that a product pay; it must be part of the best paying system. Dr. Warren held that the farm practise of a region is usually found to be quite closely adapted to its economic conditions, and that in a long-settled agricultural region any effort to decidedly change the type of farming should be undertaken only after careful study of all the factors involved.

Some dangers to be avoided in the practical interpretation of experiments on fertilizers, feeding stuffs, etc., were illustrated, and some applications of the law of diminishing returns were made to broad generalizations from such experiments. The law of supply and demand also has an important bearing on the intensity of farm practise; and it was explained that the "two-blade of grass theory," first exploited as a means of doubling

the farmer's profits, has given way to a tendency toward the other extreme which holds that good crops are an injury to the farmer since they are usually accompanied by lower prices. Both extremes were declared erroneous. The conclusion was drawn that "agricultural practise is the resultant of many forces acting in as many different directions," all of which must be fully taken into account in prescribing rules for improvement.

In considering the subject of "Regional Conditions in Determining the Type of Agricultural Inquiry," Director Youngblood took for illustration the state of Texas, which is especially well adapted to the purpose. Within the state the variation in rainfall is from 8 to 55 inches, in elevation from sea level to approximately five thousand feet, in temperature from semi-tropical to strictly temperate, and in topography from flat to rough, while the soils of different localities are derived from various phases of at least ten geological periods. And apart from these physical differences the general character of the agriculture, the distance from market, and the intellectual status of the people all have to be taken into account in adjusting the agricultural inquiry to the needs of the locality.

The plan in Texas is adapted to these diverse conditions by means of a system of branch experiment stations located in typical agricultural areas and closely articulated with a central station at the agricultural college. In a sense these branch stations represent the industries of the locality and deal largely with practical questions, the plans for the experiments all being made with the advice of the experts at the central station, where a strong scientific basis is worked out on which to rest them. Director Youngblood laid emphasis on the endeavor to educate the people to the appreciation of all agricultural investigation, however simple or technical, and he expressed the conviction that even under the new and often transitional conditions in his state technical studies may be of the greatest practical value and may be made popular with the people.

In commenting on the papers in this symposium, Dr. Jordan drew the conclusion of the value of sound research and carefully guarded interpretation. He asserted that the experiment stations have been and are still putting too much time on mere variables that have no general significance, and too little on broad fundamentals. He also called attention to the fallacy and unwisdom of attempting to state the results of experiment in terms of dollars and cents—measures which have no real permanent or scientific significance.

Dr. L. H. Bailey referred to the difficulty in interpreting in the lives of the people and in public policy the results of agricultural investigation and inquiry; and he mentioned the desirability of a large and powerful organization which should bring its influence to bear in this direction, especially in expressing the voice of science in political matters and measures of public policy.

The officers elected for the coming year were as follows: *Vice-president,* Dr. H. J. Waters, president of the Kansas State Agricultural College; *Member of the Council,* President R. A. Pearson, of the Iowa State College; *Member of the General Committee,* Dr. J. G. Lipman, of the New Jersey Experiment Stations; *Member of the Sectional Committee* (for five years), Dean A. F. Woods, of the College of Agriculture, University of Minnesota.

E. W. Allen,
Secretary

SOCIETIES AND ACADEMIES

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 506th meeting of the society was held in the Lecture Room of the Carnegie Library, on February 6. On this occasion Dr. J. Walter Fewkes, of the Bureau of American Ethnology, presented a paper on "Prehistoric Ruins of the Mesa Verde National Park," illustrated by lantern slides.

Dr. Fewkes described in detail the uncovering and repair of a large pueblo-like building in the Mesa Verde Park, near the ruin known as Sprucetree House. This work was accomplished by the speaker during the summer of 1916. The structure brought to light was 113 feet long by 100 feet wide, the ground plan showing the existence of four circular ceremonial rooms compactly embedded in fifty rectangular enclosures which were formerly used for secular purposes. From its wide southerly outlook this ruin has received the name of Far View House. It is the first pueblo habitation of this type ever found on the plateau.

After an extended consideration of the kiva or sacred room in its relation to pueblo architecture Dr. Fewkes described certain prehistoric kivas of the type generally called towers which he found in a canyon near Ouray, Utah. From their location on top of inverted cones of rock these were called by him Mushroom Rock ruins. The shape of these inverted cones of rock bore evidence to the enormous erosion which has occurred in this region.

Frances Densmore,
Secretary

SCIENCE

FRIDAY, MARCH 9, 1917

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BOTANY AS A NATIONAL ASSET[1]

IT seems timely to consider the relation of botany to national welfare, when all the sciences are being called upon to render such service as they can in the development of national resources, both material and intellectual. As botanists we realize the important points of contact between our science and human welfare, but the relation between the science of botany and these contacts is not generally appreciated. I am not concerned at present with our usefulness so much as with our reputation, which is in danger of limiting the development of both our science and our service. My attention has been called to this situation in two ways.

1. An increasing number of students of a practical turn of mind are being attracted to the physical sciences because such training is understood to connect definitely with practical activities of various kinds. These sciences are to be congratulated upon having established this connection in such a way that the general public can see it. This has not been accomplished by slighting the fundamentals, but by showing that the fundamentals must underlie all rational practise. Failure to establish this connection in the case of our science means that botany is in danger of being regarded by the general public, and by students who simply record public opinion, as the least practical of the sciences. This attitude is the result of various causes, but chief among them are the attitude of professional botanists, and the fact that the

[1] Address of the president of the Botanical Society of America, New York, December, 1916.

conspicuous practical aspects of botany have been segregated in such special institutions as schools of agriculture, quite distinct from the universities, where by implication only impractical botany is taught.

2. The recent organization of the National Research Council emphasizes the fact that botany must be recognized as a national asset to be developed. The purpose of this council is to bring into cooperation all of those scientific and practical activities which have to do with national welfare. It is an attempt to coordinate the intellectual resources of the country, so that they may be increased and may be available. Since the organization of this council, I have been asked what a botanist has to do with national welfare. This is merely an expression of what seems to be a general feeling, that botany is not a science of human interest, an impression that botanists must correct. This does not mean a revolution in our work, which must deal with the fundamentals, but we must not allow these fundamentals to remain in cold isolation, entirely unrelated to the activities of life. This is not teaching a practise, but developing a vision. In my own experience, I have found that students, while working upon the purely scientific aspects of plants, respond with what seems like gratified surprise to suggestions that all this underlies the possibility of a much more effective handling of plants in supplying human needs.

I wish now to analyze the situation, that we may have it before us clearly; and at the same time to outline the perspective that may change it, and rehabilitate botany in public estimation as the most important of all sciences to human welfare. In fact, I am asking cooperation in arousing the public to a realization of the fact that botany may be made one of the greatest assets of a nation.

We should realize first how the present condition of scholarly isolation has arisen. Men who spend their lives in universities, especially the older ones, are apt to develop certain unfortunate peculiarities. These peculiarities may not make them less happy or less useful to their professional students, but they diminish the appreciation of the community at large. There is a peculiar kind of isolation that is bound to react. It is partly the isolation of a subject which seems more or less remote from general human interests, at least in the aspects the university investigator is cultivating. As a consequence, he feels that his world is quite apart from that one in which the majority of men are living. He is conscious of an interest distinct from their interests, which seem to him therefore relatively trivial. This sense of intellectual aloofness does not result in a feeling of loneliness, but rather in a feeling of superiority; unconscious in many cases, but often naïvely expressed.

It is also the isolation of authority, which comes from the mastery of a subject and association with students who recognize this mastery. To speak with authority in a subject, to give the deciding word, to meet a constant succession of inferiors, is apt to affect any man's outlook on the world of practical affairs. Either he becomes dogmatic in expression, or he must hold himself in check with an effort.

As a consequence, men engaged in fundamental botanical research are apt to be looked upon in general as inoffensive, but rather curious and useless members of the social order. If an investigator touches now and then upon something that the public regards as useful, he is singled out as a glaring exception. If an investigation lends itself to announcement in exceedingly sensational form, as if it were uncovering deep mysteries, the investigator becomes a

marked man, and in all probability he is called a "wizard." The fact is that the great body of investigators, who are doing the substantial work that makes for scientific and practical progress, are unknown to the public. My thesis is that what may be called the pure science of botany should be recognized as underlying all the effective practical handling of plants.

For fear of being misunderstood, I wish to define briefly what I regard as the most important ideal of botany, as of all the sciences. It is to extend the boundaries of knowledge, the goal being to understand nature. This ideal includes no thought of making nature a servant to minister to our needs. To know nature simply because it is wonderful and worth knowing is what it means. Such investigation is like the exploration of an unknown continent. Every advance into the new territory impresses us with the fact that it is far more extensive than we had dreamed. Every trail is worth following because it means additional knowledge. Some trails may lead to rich farm lands and gold mines, but in exploration these are only incidents. To understand the new country, all trails must be followed and mapped.

What may be called practical botany is beginning to realize the importance of exploration. This is indicated perhaps most significantly by the change of attitude in the scientific work of the government. The Bureau of Plant Industry, for example, during the last few years has been adding notably to its staff of scientific explorers. The reason for this has been a realization of the fact that practical application is sterile unless there is a continuous discovery of something to apply.

That scientific exploration is entering upon an advanced stage of its development is shown by the fact that it is proceeding in its method from analysis to synthesis. Until recently progress in botany was marked by an increasing segregation of subjects, so that botanists were distributed into numerous pigeon holes and labeled. A man in one pigeon hole knew little of the work of his colleagues, and cared less. This segregation was immensely useful in the development of the technique of botany; but now we realize the fact that nature is not pigeon-holed, but is a great synthesis; and we know that to understand plants, which is to synthesize our results, all of our so-called sciences must focus upon the problems. We have discovered that to know plants and their relations to the synthesis we call nature, we must know not only their structure and habits, but also the chemistry of the materials that affect their living, the physics of the variable conditions that they must face, the geological record of their changes; in short, botany has become the focusing of all the sciences upon the problems of plants.

In one sense scientific exploration is a luxury, just as music or art or literature, and must be recognized as a response to a high human impulse, the impulse to *know;* but we must correct the impression that botanical exploration is merely a luxury. We have been minimizing our opportunities for botanical research by allowing the impression to continue that our results hold no relation to human welfare.

This impression has been developed chiefly by the fact that two aspects of science are generally recognized, known as "pure" and "applied." There is little general appreciation of the vital connection between these two phases of botany. Not only does the distinction exist in the public mind, but it is reinforced also by published statements from colleges and universities. The distinction seems to be that pure science is of no material service to mankind; and that, applied science

ministers to our material needs. The distinction, therefore, is based upon material output. In other words, pure science only *knows* things, while applied science knows how *to do* things. Since the modern American community believes chiefly in doing things, pure science seems to it useless, and the reaction of this sentiment upon opportunities for the cultivation of pure science is obvious.

I must confess that this feeling is too often intensified by those of us who are university investigators. We believe in knowing things, quite apart from their usefulness; and therefore we are in danger of regarding applied science as a waste of investigative energy, and its devotees appear to be unscientific; very useful, but not to be recognized as belonging to the scientific cult, the cult of explorers.

I wish now to outline a campaign of education which should lead to a general appreciation of the fact that botanical exploration can be made our most important national asset. The relation between pure and applied botany can be presented in a series of illustrations by outlining the usual steps that have been taken in the material service of botany to mankind.

In one case an investigator is attracted by a problem. No thought of its usefulness in a material way is in his mind; he wishes simply to make a contribution to knowledge. He succeeds in solving his problem and is satisfied. Later, perhaps many years later, some other scientific man discovers that the results of the former may be used to revolutionize some empirical practise of agriculture. The application is made, but the public hears only of the second man, the one who made the practical application. Obviously, however, both men were of great material service. The ratio that exists between scientific men of the first type and those of the second is not known, but there is very great disparity.

In another case, an investigator is attracted by a problem whose solution may serve the community. He succeeds in solving it, perhaps makes his own application, and is satisfied. Later another scientific man discovers that the results of the former may be used to revolutionize certain fundamental conceptions of biological science. His statement is made and the scientific world recognizes only the second man, the pure scientist, but both men were of large scientific service.

It is evident that responsibility for the practical results of our science is to be shared by those engaged in pure science and those engaged in applied science. The only distinction, therefore, is not in the *result,* but in the *intent.* In fact, the difference between pure science and applied science in their practical aspects resolves itself into the difference between murder and manslaughter; it lies in the intention. In every end result of science that reaches the public there is an inextricable tangle of contributions. Between the source of energy and the point of application there may be much machinery, and perhaps none of it can be eliminated from the final estimate of values. And yet the public has been gazing at the practical electric light, and forgetting the unseen and therefore apparently impractical power house.

All science is one. Pure science is often immensely practical, applied science is often very pure science, and between the two there is no dividing line. They are like the end members of a long and intergrading series; very distinct in their isolated and extreme expression, but completely connected. If distinction must be expressed in terms where no sharp distinction exists, it may be expressed by the terms "fundamental" and "superficial." They are terms of comparison and admit of every intergrade. In general, a university devoted to research should be interested in

the fundamental things, the larger truths that increase the general perspective of knowledge, and may underlie the possibilities of material progress in many directions. On the other hand, the immediate material needs of the community are to be met by the superficial things of science, the external touch of the more fundamental things. The series may move in either direction, but its end members must always hold the same relative positions. The first stimulus may be our need, and a superficial science meets it, but in so doing it may put us on the trail that leads to the fundamental things of science. On the other hand, the fundamentals may be gripped first, and only later find some superficial expression. The series is often attacked first in some intermediate region, and probably most of the research in pure science may be so placed; that is, it is relatively fundamental, but it is also relatively superficial. The real progress of science is away from the superficial toward the fundamental; and the more fundamental are the results, the more extensive may be their superficial expression.

In our campaign of education, which is to develop some appreciation of the fact that botanical exploration is a great national asset, concrete illustrations must be used to show that what people regard as applied science, which seems to them therefore useful and worthy of support, is but a superficial expression of fundamental things which it is the mission of pure science to discover. In other words, it must be known that the most practical science in the long run is the most fundamental.

I wish to illustrate my meaning by one concrete example, selected from many that will occur to any botanist. This will indicate how we can make the contacts between our pure science and the human welfare appreciated. The science of botany has had an interesting history. Beginning with the investigation of plants for what were called their "medicinal virtues," it developed with various progressions and retrogressions, until the botanist came to be regarded as about the most useless intelligent member of society. His chief concern seemed to remove him so far from the general human interest that he was regarded as a harmless crank at best, a man of only ephemeral interest. The most unfortunate result was that this public estimation of botany lingered much longer than it was deserved; and consequently, when the other sciences had won public esteem, either through their services or their appeal to the wonder instinct, botany lagged behind in public recognition, and in most educational institutions was the latest born in the family of sciences; but finally it also began to render signal service and appeal to the wonder instinct.

Among the several phases of botanical activity, phases which deal with the fundamentals of plant activity of all kinds, and are directly related to plant production, I wish to select plant breeding as a single illustration. It is not my purpose to recite the notable achievements that can be grouped under this title, for they are familiar to all of you. I wish simply to use plant breeding as a brief and concrete illustration of my thesis.

The *practical* aspect of plant breeding in a certain sense is as old as the cultivation of plants. Long experience in the practical handling of plants developed a kind of knowledge that became formulated in empirical practise; that is, practise whose meaning was not understood, but whose result experience assured. In general, the improvement of old forms by continuous selection grew into a fairly successful empirical practise.

During all this period of plant improve-

ment by selection, the so-called science of botany was cultivating a singularly distant field. In short, botany was not practical, and plant breeding was not scientific. As a consequence, botanists, on the one hand, and agriculturists, horticulturists, etc., on the other hand, were as distinct from one another as if they had nothing in common. It so happened that botanists were dealing with superficial problems in a scientific way, and plant breeders were dealing with the most fundamental problems in an empirical way.

As in any practise, plant breeding developed now and then an unusually successful practitioner, who made distinct contributions in the form of important results; but this represented no more of a real advance than does the fact that one cook can surpass another cook in the art of making bread.

What may be called the second period of plant breeding was ushered in when organic evolution began to be put upon an experimental basis. Plant breeding had been practical, but with no scientific basis; now a new plant breeding was established which was scientific, but with no practical motive. The new motive was the accumulation of data bearing upon the problem of inheritance. As a by-product of this work on inheritance, some of the scientific results have been applied to practical plant breeding, and the result has been an expansion of its possibilities that may well be called marvelous. In short, practical plant breeding is now on a scientific basis, and botany has at last attacked the fundamental problems and is beginning to be of great practical service.

In presenting this fleeting glimpse of the problems and accomplishments of plant breeding, I have attempted to emphasize the inextricable entanglement of pure and applied science. Any result of scientific plant breeding, representing as it must additional knowledge of the processes of inheritance, may become of practical service; and any result of practical plant breeding, involving as it does extensive experiments with plants, may prove to be of great scientific value. They are mutually stimulating, and both are necessary to the most rapid development of knowledge. This suggests that the botanical perspective to be developed in our campaign of education might be stated as practise based on science, and science that illuminates and extends practise.

In connection with the organization of the National Research Council, I feel that American botany is offered a great opportunity of which we should take advantage. As a member of the council I wish to acquaint you with its purpose, so far as botany is concerned. Since the organization of the council was stimulated by the desire to develop a program of national preparedness, the natural first impression would be that, so far as botany is concerned, it is merely the problem of more efficient food production and distribution. This would stamp the enterprise at once as a problem of practical agriculture, in connection with which botanical investigators who are dealing with the fundamental problems of plants would have little or no part. Nothing is further from the intention of the council. The chairman has recently outlined the work of the council briefly as follows:

1. To prepare a national census of research, showing what laboratories and investigators are available.

2. To encourage the cooperation of educational and research institutions in working out problems of pure science and industry.

3. To promote research in various branches of science in cooperation with leading national scientific societies.

4. To encourage scientific research in educational institutions. It is proposed, for instance,

that in each advanced educational institution there be a committee on research to promote original investigations on the part of the faculty and graduate students.

5. To establish research fellowships in educational institutions, thus affording qualified workers an opportunity to devote themselves entirely to research work.

6. To secure wherever possible endowments for research purposes.

It is evident that so far from being primarily work in the practical application of what we know already, the enterprise is intended to be primarily a stimulus to fundamental research in every direction. It is not *practical application* that is to be stimulated chiefly, but *exploration*, which may or may not result in practical application. It is felt, for example, that the more we know about the structures and activities of plants, the better equipped we shall be to handle plants intelligently. Our botanical program, therefore, is simply to extend the boundaries of our knowledge of plants as far as possible. In pursuance of this program, at least two things are felt to be necessary.

In the first place, there must be developed some scheme of cooperation among our botanical establishments; and notably between the research establishments and the so-called practical establishments. For example, we recognize in general three great botanical agencies at work to-day, working independently, and in too great ignorance of each other's results. These agencies are the Department of Agriculture, the agricultural colleges and experiment stations, and the universities. All of these agencies are investigating plants from various points of view, but they are not as mutually helpful, or even as mutually stimulating as they should be in the interest of progress. I have met many cases of men intellectually equipped to work, but with no adequate material or equipment; and also even more cases of fine equipment and abundant material, and no man trained to use them effectively. In other words, the distribution of men and equipment is not as effective as it should be.

In the second place, there must be developed some plan of supporting research wherever there is a competent investigator. The movement to establish research fellowships has begun already, and as the value of research becomes better understood, there is no reason to doubt that every botanical explorer will have the opportunity to explore. There is at present a tremendous amount of waste in the investigators produced by the universities. Every year scores of young investigators, well equipped to continue exploration, are automatically side-tracked by a degree, and forced into positions where investigation is killed, or at least becomes anemic. The council proposes to conserve some of this investigative ability, and to give it a chance to express itself. In short, the opportunity now presented to us is to increase the opportunities for botanical research to such an extent by cooperation and conservation of investigative ability that the progress of botany should take on a greatly increased momentum. And all this can be done if at this psychological moment we as botanists can make it clear that a fundamental knowledge of plants is a great national asset.

JOHN M. COULTER
UNIVERSITY OF CHICAGO

THE COMMITTEE OF ONE HUNDRED ON SCIENTIFIC RESEARCH OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORT OF THE SUBCOMMITTEE ON ENGINEERING

IN view of the fact that a subcommittee on engineering has only very recently been appointed by the American Association for the Advancement of Science committee of one

hundred on scientific research, no report concerning actions or accomplishment can be submitted at this time. A few suggestions may be offered, however, bearing upon the activities of an engineering research committee.

Researches in engineering may be divided into two classes; namely (1) those undertaken for the assistance of some particular industry or manufacture, and (2) those undertaken for the advancement of technical knowledge or applied science. Industrial researches are numerous, and have a great history; but very little literature. They also have a great range of character and intensiveness, say from overcoming, in a few minutes, certain little mechanical difficulties in the behavior of a machine, to scientific investigations pursued systematically for years, perhaps with a staff of trained technicians, say for the purpose of developing some important industrial process. The amount of industrial research going on in the country is, in the aggregate, very great, and is likely to increase as time goes on and industries further specialize. Many of these problems of industrial research fall within the professional province of consulting engineering, and indeed few new large engineering undertakings can be met without involving some new industrial research. The characteristic quality of industrial research is that it does not find direct or immediate publication. Probably much of it is eventually published either in the form of engineering data or in patent specifications; but the competition between branches of industry almost inevitably demands that the scientific or technical underlying progress should be protected. The industrial value of successful researches may be so great that their nondisclosure is a first consideration in reward of the necessary labor and expense. The hope and justification of industrial research is that it may, and often does, pay for itself. In many instances it has paid most handsomely.

On the other hand, the second type of research, *i. e.*, engineering researches or researches for engineering development may also cover a great range of quality and intensiveness from say brief tests of the performance of some machine, to elaborate investigations in mathematics, physics, chemistry or economics. Such engineering researches may either be intensely practical on the one hand; or they may be outside of the immediate fields of scientific application, and differ in no evident way from so-called pure scientific enquiry, paving and prospecting the ways for future use in engineering. The characteristic quality of these engineering researches is that in-so-far as they are successful they tend to find direct and immediate publication, and so to become available for the use of all concerned.

It is evident that engineering technological researches may be of great value to a country or to industries; but that they inherently lack self-support. Any laboratory engaged in researches, the successful results of which are to be published, can only expect to be supported either by national institutions, by gifts, or by benevolent endowment. For this reason, although industrial researches are numerous and widespread, engineering researches are mainly restricted to universities, technical colleges and government laboratories.

It would seem to be desirable that the laboratories in which engineering researches are carried on should all be brought into some cooperative association, not only for mutual benefit, but also for the benefit of engineering, and of the country at large, through engineering. It is desirable that each and every technological laboratory should develop a specialty or a group of specialties. The tendency in the past has been for essentially the same course of engineering studies to be pursued in the technical colleges, and in natural conformity therewith, the laboratory investigations have been more or less of the same type. In order, therefore, to develop greater advantages from cooperative effort, such specialties as happen to develop in the researches of technological laboratories should be fostered and encouraged, so long as freedom of individual action is not restricted.

The encouragement of specializing in engineering researches, for the greater good of

the country and of the world, can be effected by the Association for the Advancement of Science through the recognition of such specialization as spontaneously occurs, through grants for the solution of particular problems, and through assistance in finding adequate publication for the results that may be obtained from engineering researches.

A. E. KENNELLY

CAMBRIDGE, MASS.

REPORT OF THE SUBCOMMITTEE ON PATHOLOGY

THE Committee on Research in Pathology recommends:

1. *Nature of Work to Be Aided.*—In the awarding of grants that preference be given to problems of etiology, immunity, functional pathology and chemical pathology, as representing the most profitable lines of investigation at present.

2. *Laboratories or Individuals to Be Aided.*—It is believed advisable to give grants preferably to laboratories presided over by a director of known training and ability in investigation, the funds of which are insufficient to meet the needs for special studies. This does not necessarily rule out an exceptional man in a laboratory indifferently manned, but it must be remembered, as a general proposition, that laboratories which need the money most are, on account of poor equipment and the lack of adequate staff, least prepared to use it to advantage. The best policy is to give where most can be accomplished and not where money is most needed.

It is undesirable to give money solely to encourage research in a general way by younger men under direction of the laboratory head. The aid should be for a definite problem of recognized importance and should be preferably to men of wide experience as investigators, and as far as possible to heads of departments, who will take an active part in the work, aided perhaps by their assistants.

In addition to departments of pathology, those of bacteriology, protozoology and immunology, or clinical medicine possessing well-equipped laboratories for investigation along any of the lines before mentioned shall be considered as conducting research in pathology and eligible for grants. The sole conditions for the award of a grant should be (1) The formulation of a suitable problem; (2) the proposal of definite methods for its solution; (3) the possession of facilities adequate for the successful prosecution of the projected investigation.

3. *Amount of Grants.*—In view of the position taken in Section 2 it is recommended that grants of relatively large sums (several hundred dollars) be given to a few laboratories rather than smaller sums scattered more widely. These larger sums would ensure, presumably, an adequate return and would offer a greater incentive to concentrated work on important problems.

4. *Cooperation.*—It is considered desirable for the committee to keep in touch with other organizations, as the Rockefeller Institute for Medical Research and the Research Committee of the American Medical Association, offering grants for research in medicine in order (*a*) to avoid duplication of grants, (*b*) to exchange lists of applicants, (*c*) to profit by the experience of these organizations.

5. *Publicity.*—It is considered inadvisable to issue a general request for applications. The publication in SCIENCE and the *Journal of the American Medical Association* of the report of the committee should place the matter before the proper audience and lead to requests from individuals, presumably heads of departments most interested in such aid and best prepared to take advantage of it.

THEODORE C. JANEWAY,
EUGENE L. OPIE,
H. GIDEON WELLS
RICHARD M. PEARCE (chairman),
University of Pennsylvania,
Philadelphia, Pa.
PEYTON ROUS (secretary),
Rockefeller Institute,
New York City

REPORT OF THE SUBCOMMITTEE ON MATHEMATICS

IN view of the proposed plan to form research committees with the direct cooperation of various scientific organizations, the

subcommittee on mathematics decided not to attempt to present a formal report at this time. I desire, however, to take advantage of this opportunity to emphasize the fact that mathematical research is probably no less dependent upon financial support than research in the other scientific subjects.

It is true that the mathematical investigator seldom needs costly equipment beyond good library facilities, but what he gains in this direction he loses as a result of the fact that his most important discoveries frequently require very extensive development before they are fully appreciated even by the mathematical public. In some scientific fields discoveries of the greatest popular interest can be announced effectively in a few words, and hence the publications necessary to meet the direct needs of the investigator in these fields are comparatively inexpensive.

The lack of funds for the publication of extensive mathematical treatises and memoirs has had very baneful consequences. In the case of treatises on modern subjects the scientific value often increases much more rapidly than the size of the treatise. If an author who is perfectly competent to prepare a treatise of six hundred pages on such a subject is compelled to limit himself to four hundred pages, he usually finds it necessary to omit the developments which are most original and which would reflect most honor on the author and on the country in which the work is published.

The intrinsic scientific value of mathematical memoirs is usually not very seriously affected by brevity in presentation. On the other hand, this brevity tends to reduce the immediate influence of these memoirs, since it increases enormously the difficulties met by those who try to master them. The mathematical reader is often compelled to waste much time in trying to decipher what the author could have exhibited clearly if he had had a few more pages at his command. As compared with European publications American mathematical literature includes a comparatively small number of extensive memoirs.

The most expensive element tending to improve research conditions is the providing of sufficient free time for the investigator. In this respect mathematics does not present a problem which differs materially from that presented by other subjects, unless it is assumed that the very abstract nature of his subject makes it unusually difficult for the mathematician to utilize odd moments. At any rate, I hope I have succeeded in making clear that American mathematical research could be greatly improved by more liberal financial support, and I presume the importance of mathematical developments needs no emphasis before a body of scientists.

G. A. Miller,
Chairman

SCIENTIFIC NOTES AND NEWS

Dr. J. H. Long, dean of the school of pharmacy and professor of chemistry at Northwestern University, has been elected president of the Chicago Institute of Medicine for the year 1917.

The Royal Geographical Society of London has elected Dr. Charles Doolittle Walcott, secretary of the Smithsonian Institution, a corresponding member.

Dr. J. J. R. Macleod, professor of physiology, school of medicine, Western Reserve University, has been granted leave of absence to act as professor of physiology in McGill University, Montreal, during the months of February and March.

Professor Waldemar Lindgren, of the Massachusetts Institute of Technology, has gone to Chile in connection with geological work on some of the copper properties.

The honor of knighthood has been conferred on Professor Jagadish Chandra Bose, of Calcutta, known for his work in physics and physiology.

Professor A. N. Whitehead has been elected president of the British Mathematical Society.

Major P. A. MacMahon has been elected president of the Royal Astronomical Society in succession to Dr. R. A. Sampson.

Dr. Smith Ely Jelliffe, of New York City, has been appointed editor of the *New York*

Medical Journal to fill the vacancy caused by the death of Dr. Claude L. Wheeler. Dr. Jelliffe was editor for several years of the *Medical News* before that periodical was discontinued, and is now managing editor of the *Journal of Nervous and Mental Disease.*

DR. MARY GAGE DAY, a sister of Professor S. H. Gage, of Cornell University, is leaving Kingston, N. Y., to make her home with her brother in Ithaca and devote her time to researches in biology. During the last twenty years she has practised medicine in Kingston.

MR. F. E. KEMPTON, assistant in the department of botany at the University of Illinois, has been granted leave of absence to take up the work of a plant disease survey for the St. Louis Smelting and Refining Company in the vicinity of their plant at Collinsville, Ill.

THE Arkansas Academy of Sciences was formally organized on January 11 at a banquet held at Little Rock for that purpose. Officers for the ensuing year are Charles Brookover, president; Morgan Smith, vice-president; Dewell Gann, Jr., secretary; Herbert A. Heagney, treasurer; Troy W. Lewis, permanent secretary. The meeting for 1917 will be held at Little Rock on October 12 and 13. We are requested to state that the Arkansas Academy of Sciences desires to affiliate with other scientific societies.

THE following awards of the Society of Engineers (incorporated) were presented on February 5: The president's gold medal to Professor C. G. Cullis for his paper on "The Mineral Resources of the British Empire as regards the Production of Non-Ferrous Industrial Metals"; the Bessemer Premium to Professor W. G. Fearnsides for his paper on "The Mineral Requirements of the British Iron and Steel Industries"; the Bernays Premium to Professor J. A. Fleming for his paper on "Engineering and Scientific Research"; the Nursey Premium to Mr. J. E. Lister for his paper on "Modern Coal and Coke Handling Machinery as used in the Manufacture of Gas"; and the Society's Premium to Mr. Ewart S. Andrews for his paper on "The Design of Continuous Beams."

A COMMITTEE of the Cornell Society of Civil Engineers is receiving contributions to a fund for a testimonial to Professor Irving Porter Church. A part of the fund will be expended for a portrait of Professor Church to be presented to the university. The remainder will be used for a gift to the university in his honor.

AN oil portrait of Professor O. T. Bloch, according to the *Journal* of the American Medical Association, was hung recently with appropriate ceremonies in the hall of the Surgical Academy at Copenhagen, in preparation for his approaching seventieth birthday. The surplus left from the subscriptions for the portrait was presented to him, and he turned it over to the building fund of the medical society. He was for a long time on the editorial staff of the *Hospitalstidende* and has published numerous works in this and in Scandinavian, British and French surgical journals. He has also published several books, including one on the history of treatment of wounds from the earliest to modern times.

DR. MARTIN H. FISCHER and Joseph Eichberg, professors of physiology, University of Cincinnati, and Dr. Ludvig Hektoen, head of the department of pathology, University of Chicago, have been elected Cutter lecturers on preventive medicine and hygiene at Harvard University for the academic year 1916–17.

DR. A. HOYT TAYLOR, head of the department of physics of the University of North Dakota, has given a series of two lectures at Northwestern University and the Chicago Academy of Science on "Recent Advances in Radio Communication" with demonstrations of wireless telephony and telegraphy. Radio signals were amplified so as to be audible to an audience of several hundred and a musical concert was received by wireless telephone from a station some eight miles distant.

MR. JONATHAN HUTCHINSON gave the Hunterian lecture before the Royal College of Surgeons of England on February 12 on "Dupuytren's Life and Surgical Works."

ARNOLD VALENTINE STUBENRAUCH, professor of pomology in the University of California,

died at his home in Berkeley on February 12, 1917. A graduate of the University of California of 1899, Professor Stubenrauch was for ten years in the U. S. Department of Agriculture, resigning in 1914 his position as pomologist in charge of field investigations to return to service in the University of California. He was the first man to demonstrate that dates could be grown with commercial success in the Imperial Valley, on the desert in southern California; in association with G. Harold Powell he developed the pre-cooling method, which has greatly contributed to success in the shipping of fruit from California; he demonstrated that California grapes could be kept safely in cold storage for months if packed in redwood sawdust. He was of unusual power as a teacher and a stimulator of scientific activity.

Dr. C. V. Burton, known for his contributions to experimental and theoretical physics, died on February 3, owing to an accident at a British aircraft factory.

The death in Paris is announced of Dr. Jules Dejerine, a member of the Paris Academy of Medicine and well known as a neurologist, at the age of sixty-eight years.

A. Pappenheim, privat-docent at the University of Berlin, noted for his work on the morphology of the blood and the blood diseases, editor of the *Folia hæmatologica,* and the author of a work on the chemistry of dyestuffs, recently succumbed to typhus acquired in his professional work.

It is stated in the *Experiment Station Record* that plans have been approved by the building committee for the new agricultural building at the Maryland College for which $175,000 was appropriated by the last legislature. A three-story and basement structure, with a front wing 200 by 68 feet, connected by an enclosed bridge with an auditorium seating about 1,000 people, and this in turn connected with a rear wing of the same dimensions as the front, is contemplated. The front wing is to be used for offices and classrooms and the rear wing for stock judging and exhibitions and experimental work. It is hoped that the structure will be ready for use next fall.

According to the *Journal* of the American Medical Association, Dr. Raymond Tripier, of the School of Medicine, Lyons, whose death was announced in December, bequeathed to the University of Lyons 200,000 francs for the encouragement of special work in operative medicine and pathologic anatomy. He also bequeathed to the city of Lyons the sum of 200,000 francs, the annual interest of which will permit the acquisition of a work of art every five years.

The Liebig Scholarship Society of Germany has recently been formed, with a capital of upwards of a million marks from German industries, for the purpose of assisting young German chemistry students to proceed with their studies, after their examinations, by working as assistants in the technical high schools.

There has been organized at the University of North Carolina a mathematical club whose members are drawn from the instructors and graduate students of the mathematical and allied departments. The following officers have been elected: Wm. Cain, president; Archibald Henderson, vice-president; J. W. Larley, Jr., secretary.

The third annual meeting of Entomological Workers of Ohio was held at Ohio State University on February 2, with thirty members in attendance. The program consisted of reviews of projects and reports on investigations of members of the Ohio Experiment Station, the State Division of Orchard and Nursery Inspection and the department of entomology of the university.

The council of the British Association of Chambers of Commerce is, as we learn from foreign exchanges, considering draft bills designed to carry out reforms in our systems of weights and measures and of coinage, and should the council approve of them they will be submitted to the Chambers of Commerce throughout the country. If there proves to be general agreement the association's bill will be introduced into Parliament. It is probable that a bill for establishing a decimal coinage will have first attention, the bill for introducing metric weights and measures not being pressed until the country has grown accus-

tomed to a decimal coinage. It is suggested that the simplest means of making the change would be the adoption of the present florin, which is the tenth part of a sovereign, as the unit. The existing farthing would be replaced by a "cent," equal to the hundredth part of a florin, instead of a ninety-sixth part as now. Sir Edward Holden, at the meeting on January 26 of the London City and Midland Bank, of which he is chairman, expressed himself strongly in favor of the adoption by Great Britain of the metric system.

A press bulletin of the Geological Survey calls attention to the fact that the press dispatches describing the latest eruptions of Lassen Peak show a continued tendency to refer to the volcano as Mount Lassen. Perhaps it is thought that the name should correspond with those of some other famous peaks of the Cascade Range, such as Mount Shasta or Mount Rainier. But Lassen Peak, as the most active and interesting volcano in the United States, is especially entitled to be called by its own name, and acts of Congress and Presidential proclamations in creating and recognizing the Lassen Peak National Forest and Lassen Peak National Monument have given the name Lassen Peak a status of high rank in the geologic annals of the Cascade Range. The area has recently been set apart as the Lassen Volcanic National Park. The name Lassen Peak, according to the United States Geological Survey, Department of the Interior, is the only authorized form on maps, reports and gazetteers from the Whitney Geological Survey of California, in 1865, to the geomorphic map of California and Nevada published by the Earthquake Investigation Commission, as well as on the latest map issued by the Forest Service. Peter Lassen, the sturdy pioneer who guided many an early settler to the sunny lands of the Sacramento, lies buried in a lonely grave in Lassen County. A small, crumbling monument thirty miles from the peak marks his final resting place, but his greater and more enduring monuments are the county and peak named in his honor by a grateful people. The snow-capped Lassen Peak has piloted many an immigrant to the mountain pass. In the early days of the Pacific Railroad surveys some pious monk called the peak St. Joseph's Mountain, but the names Lassen's Peak and Lassen's Butte soon came into general use. Whitney has shown the inappropriateness of the French term butte, which, translated exactly, means knoll. As Lassen never owned the mountain, in later years the possessive form of the name was dropped, and to correct an illicit tendency to wander from well-established usage the United States Geographic Board, in its decision of October 9, 1915, officially recognized the fact that the name of the mountain was *Lassen Peak,* not Mount Lassen.

The United States Civil Service Commission announces an examination for expert electrical and mechanical aid, to fill a vacancy in this position at $12.48 per diem, in the Bureau of Yards and Docks, Navy Department, Washington, D. C., and vacancies as they may occur in positions requiring similar qualifications. The duties of this position cover the expert maintenance and supervision of the operation of all navy-yard power plants, embracing the economical production, distribution and utilization of electric power for manufacturing, pumping dry docks, charging submarines, and tral heating, and production and distribution of for manufacturing; steam for power and central heating, and production and distribution of hydraulic power; also investigations of power-plant operating conditions, tests of plants and equipment, and efficiency engineering work in connection with improvement of operating conditions and instruction of plant operatives to obtain economical operating results. Competitors will not be assembled for examination, but will be rated on technical education, experience and fitness. Graduation with a degree of mechanical engineer or electrical engineer from a college or university of recognized standing, and at least ten years' subsequent experience in responsible charge of the design, installation and operation of central power plants and distribution systems for light, heat and power, with executive experience in handling successfully large numbers of power-plant employees, are prerequisites for consideration for this position.

A letter received at the Harvard College Observatory from Professor Henry Norris Russell, director of the Princeton University Observatory, contains the following preliminary values of the parallax of the star of large proper motion in Ophiuchus which have been determined by him from micrometric observations communicated by Professor Barnard. From the differences of the distances of stars a and k, a solution in which the proper motion is eliminated in the usual manner gives a parallax of $0''.69 \pm 0''.06$. Measures of positives made from the plates of 1894 and 1904, when compared with the measures of 1916, give a proper motion of $10''.38$ toward $355°.8$. Assuming this proper motion, the distance measures of the stars a, c and k give parallaxes of $0''.85$, $0''.53$ and $0''.66$, and the measures of position angle a mean parallax of $0''.75$. The mean of these determinations is $0''.70 \pm 0''.05$. The absolute magnitude of this star on Kapteyn's scale is 13.6, and its real brightness is less than one three-thousandth that of the sun, making it the faintest star so far known.

UNIVERSITY AND EDUCATIONAL NEWS

The University of California has received through the death of Mrs. Elizabeth Josselyn Boalt an endowment of $200,000 for the maintenance of professorships in law.

At a meeting of the governors of the South Wales University College, called to consider proposals for providing better science teaching after the war, it was reported that Sir W. J. Tatem had promised to provide a chemical laboratory which would cost at least £25,000, and that other promises included 1,000 guineas from the late Mr. Beaumont Thomas, 1,000 guineas from Mr. Dan Radcliffe, 1,000 guineas from Mr. J. Herbert Cory, M.P., 1,000 guineas from Mr. W. Beyron, and 2,000 guineas each from Mr. Morgan Wakely and Mr. Percy Miles.

Having decided to open its courses to women as soon as proper facilities can be provided, the college of physicians and surgeons, Columbia University, is now appealing for immediate contributions of $50,000, so that these facilities may be secured and women admitted to the school next September. It is proposed to erect a small addition to the present college buildings, sufficient to provide for the women students, until such time as new quarters are provided for the entire college.

On February 23 the regents of the University of Michigan adopted a resolution confirming the union with the University of Detroit college of medicine and surgery. The terms of the merger are that the latter shall turn over its charter, real estate, equipment and hospital privileges to the university and that a fund of a million dollars will be raised for the development by the university of a graduate school of medicine in Detroit.

Dr. Theodore Lyman and Dr. George W. Pierce have been promoted to professorships of physics at Harvard University.

Dr. George B. Pegram, professor of physics at Columbia University, has been appointed to be dean of the school of applied science to succeed Frederick A. Goetze, who is now treasurer of the university.

Professor Raymond C. Osburn, professor of biology at the Connecticut College, New London, Connecticut, has been elected head of the department of zoology and entomology of the Ohio State University, his appointment to take effect July 1. He will assume the duties carried for the last nineteen years by Professor Herbert Osborn, who was last year elected research professor and who will hereafter give his entire time to research work, including the direction of research by graduate students, and, for the present, the directorship of the Lake Laboratory and of the Ohio Biological Survey.

Professor Dr. O. van der Stricht, professor of histology and embryology, University of Ghent, Belgium, has been reappointed research fellow in cytology, school of medicine, Western Reserve University.

Dr. P. N. van Kampen, university lecturer at Amsterdam, has been appointed professor of zoology and comparative anatomy in the University of Leyden, in succession to the late Professor Vosmaer.

DISCUSSION AND CORRESPONDENCE

A CULTURE MEDIUM FOR EUGLENA

A MEDIUM discovered quite by accident has enabled the writer to carry on vigorous cultures of *Euglena* for a period of more than a year. Some five hundred cultures have proved conclusively that it is a success. The medium is quince-seed jelly, which is in common use as an agent for retarding the movements of Protozoa. It is prepared by boiling quince seed in distilled water, passing the thick, glutinous mass which is obtained through a sieve to remove particles of the seed and then diluting with distilled water to the desired consistency. Cultures have been carried in test tubes, jars, flasks and other receptacles. Some tubes remained corked throughout the entire year and were found to contain virile cultures at the end of that time.

The jelly seems to be specific for *Euglena*, some other chlorophyll-bearing Protozoans and for bacteria. Tubes were inoculated with cultures of mixed Protozoans and after a period of two months only the *Euglena* and a minute green flagellate survived, the other Protozoans living only as long as the supply of bacteria lasted.

Two hundred successful transplants have been made from a single culture.

The medium has several obvious advantages:

1. It enables the operator to carry on cultures for a long period of time without giving them constant attention.

2. The medium is viscid and evaporates rather slowly.

3. A constant as regards density and chemical content may be obtained for experimental work by evaporating the medium to dryness and making up a standard solution with distilled water.

The results of a year's experiments together with some notes on the behavior of *Euglena* are soon to be published.

CLARENCE L. TURNER
DEPARTMENT OF ANATOMY AND BIOLOGY,
MARQUETTE UNIVERSITY SCHOOL OF MEDICINE

A RELIEF MAP OF THE UNITED STATES

TO THE EDITOR OF SCIENCE: The article entitled "Expedite the Map," which appeared in the October 13 issue of SCIENCE, brings to mind the desirability of having in the city of Washington, suitably housed, a large scale relief map or model of the United States.

This model might be about 300 feet square or 600 feet square, according to the structural difficulties which would be encountered and the amount of appropriation which could be obtained from Congress or other source.

As to the appropriation, I doubt that it would be easy to secure funds from Congress for an object of this kind, and I believe that it would be better to depend upon private philanthropy to secure the financial foundation needed.

The statement "Every industry, art and science which demands a knowledge of the lay of the land is benefited by good maps of the area in which it is carried on," and the remainder of the paragraph from which this sentence is quoted apply equally to a relief map.

Such a map, if constructed, would be available for consultation by members of Congress, bureau officials and by the general public; and it would be one of the sights of the national capital. The main problem is to find the philanthropist.

T. W. KINKAID

LEIDY ON THE CAUSE OF MALARIA: A CORRECTION

IN a letter to Professor Henry Fairfield Osborn, published by him in his "Biographical Memoir of Joseph Leidy,"[1] I stated that in 1853 Leidy "discussed the cause of malaria and wrongly concluded that it is not of parasitic origin." Dr. Joseph Leidy, 2d, has kindly called my attention to my regrettable blunder. What Leidy really said[2] was:

> That malarial and epidemic fevers have their origin in cryptogamic vegetables or spores requires yet a single proof. If such were the case, these minute vegetables and spores, conveyed through the air, and introduced into the body in respiration, could be detected.

FRANK E. LUTZ

[1] National Acad. Sci., Biographical Memoirs, VII., 1913, p. 356.

[2] Smithsonian Contrib. Knowledge, V., 1853, p. 14.

SCIENTIFIC BOOKS

Water Supply. By WILLIAM P. MASON. Fourth Edition. New York, John Wiley and Sons. x + 528 pages, 6/9. $3.75 net.

The fourth edition of Professor Mason's well-known book on water supply testifies to the high esteem in which this book is held by the American engineering public. Published originally in 1896 it has passed through subsequent editions, each time being substantially enlarged and improved. For the present edition a large amount of the text has been entirely rewritten and suitable amount of new material added. The tables have been brought up to date and new photographs introduced. Some of the most noticeable changes are the following:

The chapter on Drinking Water and Disease has been strengthened by the addition of many pages devoted to typhoid fever. The work of recent years is drawn upon to set forth present-day conceptions in regard to the existence of the typhoid bacillus outside its human host and in "carriers." The distribution of the disease and factors operating in its transmission are also discussed. Considerable material has been withdrawn from this edition relative to the now discredited theory of water-borne malaria.

Newly developed methods of water purification, particularly processes aiming at disinfection, come in for consideration, as do certain newly found factors influencing natural purification in streams and stored waters. The use of chlorine ozone, ultra-violet light and copper sulphate receive attention. There is considerable discussion of various phases of the pollution of drinking water supplies and the care of watersheds.

Revisions and additions appear frequently throughout the chapters dealing with ground water and with the corrosive action of water. The appendices deal with entirely new subjects and are brief.

Professor Mason is always a pleasing writer and has the art of abstracting the important data from the writings of others and presenting them in an attractive form. Although this can not be called an exhaustive treatment of the subject it is one of the most interesting and suggestive treatises on water supplies published since the old book of the same title by Professor William Ripley Nichols, of the Massachusetts Institute of Technology.

GEORGE C. WHIPPLE

HARVARD UNIVERSITY

Sarcophaga and Allies in North America. By J. M. ALDRICH. Published by the Entomological Society of America. Lafayette, Indiana, 1916.

In 1915 the Entomological Society of America, recognizing the difficulty of adequately publishing monographs on American insects, established the Thomas Say Foundation for this purpose. Subscriptions were solicited, and the accumulating funds were set aside to be used from time to time as suitable works might be offered for publication. The plan is not unlike that of the English Ray Society, which has been publishing important zoological works for many years. Very appropriately, the Foundation is named after Thomas Say, the founder of American entomology. The first monograph issued under these auspices is now before us, and is a revision of the Sarcophagid flies, commonly known as flesh-flies, by Dr. J. M. Aldrich. These flies, which are very abundant in America and Europe, and in some cases of considerable economic importance, have long been the despair of students. It was recognized that the species were numerous, and in fact over a hundred supposed species had been described, but no one could satisfactorily identify them. About twenty years ago L. Pandellé published a work in France, in which he separated the European species known to him by the characters of the sexual organs. This method proved brilliantly successful, and after a time was confirmed and adopted by the other European workers. It is now applied to the American flies, with the result of making the whole subject over, and replacing chaos by order. Dr. Aldrich has been able to recognize 145 species and varieties in the American fauna, and figures the genitalia of 138. Every reasonable effort has been made to identify the earlier

described forms, but since the older authors had little or no conception of the true specific differences in this group, many names have necessarily been set aside as practically meaningless. The treatment throughout is full and sufficient; the genera and species are separated by keys, and the descriptions of the species are quite detailed. Types are carefully designated, and localities and collectors are cited. Biological details are given when available. In all respects the book worthily initiates a series which may be expected to take first rank among those devoted to zoological subjects.

From a postscript at the end it appears that two of the species described by Dr. Aldrich were published a little earlier, under quite other names, by Dr. R. R. Parker. It seems strange that when there are only two persons in the Western Hemisphere working on a subject, they can not consult together sufficiently to avoid such conflicts. Figure 110, as I learn from Dr. Aldrich, though labelled *Sarcophaga bison* is in fact *S. bullata* Parker. The former name was a manuscript one of the author's, and was altered in the text at the last moment, because Dr. Parker published the species as *bullata*.

We hear much these days about the encouragement of research, but it is often overlooked that adequate facilities for publication are essential. Authors are not justified in spending months and years in the preparation of monographs which may never appear in print or serve any useful purpose. There are at this moment many excellent contributions the publication of which is indefinitely postponed, or which must be split up into short papers in order to see the light. To those who are familiar with actual conditions the situation is rather discouraging, and it is not mended by the appearance of a certain number of large books in sumptuous and extravagant form. The Thomas Say Foundation, from necessity no less than choice, publishes as cheaply as is consistent with excellence, and in this respect earns the gratitude of students.

T. D. A. COCKERELL
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THE ORIGIN OF THE PRE-COLUMBIAN CIVILIZATION OF AMERICA

MY attention has just been called to the letters (SCIENCE, October 13, 1916) in which Dr. A. A. Goldenweiser and Mr. Philip Ainsworth Means have put a series of questions for me to answer. As the problems to be solved involve the validity of the foundations upon which has been built up (as the result of more than half a century's intensive studies on the part of leading scholars of every civilized country) a vast superstructure of ethnological doctrine and complex rationalization, perhaps you will afford me the opportunity of replying in some detail to these criticisms, and of adding to the article of mine which appeared in SCIENCE on August 11, 1916, some further reasons for thinking that this elaborate edifice of ethnological speculation will have to be demolished.

While admitting that in the end my contention may be justified, Mr. Means makes the significant comment that "it will be a long time before American anthropologists will be forced to accept these views as final." All that I have attempted to do is to "force" them seriously to examine the foundations of their beliefs, being firmly persuaded that such of them whose minds are still sufficiently alert to be no longer blinded by the outworn dogmas of Bastian and Tylor[1] will be led to accept the views which I have sketched as the only possible interpretation of the facts.

One of the three difficulties suggested by Mr. Means I have already discussed at some length.[2]

[1] By the same mail that brought me the proofs of this letter also came the tidings of the death of the veteran ethnologist whose teaching is so frankly criticized in it. But though his theories of "animism" and "independent evolution of culture" have been a serious factor in clouding the vision of ethnologists, the great merit belongs to Sir Edward Tylor of stimulating a widespread interest in the subject and thereby contributing materially to the advancement of learning, which has earned him the grateful tribute of all scholars.

[2] "Ships as Evidence of the Migrations of Early Culture," *Journal of the Manchester Egyptian and Oriental Society*, 1916.

It is significant that, when citing six memoirs relating to shipping, some of them quite irrelevant, Mr. Means should have omitted all reference to the writings of Pâris, Pitt-Rivers, Assmann and Friederici, where he will find the evidence he imagines to be non-existent. But does the argument from ships really help his case? Where is the "similarity of the working of the human mind" if the highly civilized people of Peru and Mexico hadn't sufficient of what Dr. Goldenweiser calls "happy thoughts" to accomplish more in the way of ship-building? Is not this paucity of shipping merely a token of the remoteness of America from the home of its invention?

The fact that the culture-bearers who first crossed the Pacific by the Polynesian route were searching for pearls and precious metals[3] is surely a sufficient explanation of their desertion of the sea once they reached the American eldorado.

Another of Mr. Means's difficulties I fail to understand. Why was eight centuries too brief a time for a ship to have made its way from the Red Sea to America? Before the introduction of steam-ships what was to prevent a vessel doing the journey as quickly in the eighth century B.C. as in the eighth, or perhaps even the eighteenth, A.D.? There are reasons, given in detail by Aymonier and others, for believing that western culture had already made its influence felt in Cambodia before the close of the seventh century B.C.: Indonesia and even Japan received the leaven at the same time: and it can hardly be in doubt that the ancient mariners did not limit their easterly wanderings to Indonesia, but pushed out into the Pacific, and soon afterwards crossed it to America.

The remaining difficulty which is holding Mr. Means back is that the Pre-Columbian Americans did not use wheeled vehicles. Seeing that the whole of the migration, which I have described as extending from the Red Sea to America, consisted of a series of maritime expeditions, it is not altogether clear what Mr. Means is referring to when he asks:

> Is it not inevitable that they would have made use of such vehicles during their long journey?

At the time the great cultural movement took place it is quite likely that none of the wanderers had ever seen, or even perhaps heard of, a wheeled vehicle. Even if, on some rare occasion of state, in Egypt or one of the Asiatic monarchies, they had seen the king drive in a chariot, was that an adequate reason why these sailors, when, after many years of adventure, they at last reached the American coast, teeming with the spoils they coveted, should have remembered the chariot, and at once set to work to build carts and train llamas to draw them? Surely the utter improbability of this whittles down Mr. Means's difficulty to the vanishing point. Or alternatively, if there is any substance in the "psychic unity" hypothesis, why didn't the Americans get a "happy thought" and invent "so simple and obvious a device" as a wheeled vehicle?

Dr. Goldenweiser's objections are much vaguer and less well-defined. From the latter part of his letter I gather that he is not acquainted with what I have written elsewhere on this subject.[4]

At the outset I must repudiate Dr. Goldenweiser's unwarranted charge that I have "apparently embraced the articles of the Graebnerian faith." My attitude towards the problems of ethnology is that which prevailed

[3] W. J. Perry, "The Relationship between the Geographical Distribution of Megalithic Monuments and Ancient Mines," Manchester Lit. and Phil. Soc. Memoirs, November, 1915; and J. Wilfrid Jackson, "The Geographical Distribution of the use of Pearls and Pearl-shell," *ibid.*, September, 1916.

[4] "On the Significance of the Geographical Distribution of the Practise of Mummification," Mem. and Proc. Manchester Lit. and Phil. Soc., July 7, 1915; republished by the Manchester Univ. Press under the title "The Migrations of Early Culture," August, 1915; "The Influence of Ancient Egyptian Civilization in the East and in America," *Bull. John Rylands Library,* March, 1916; "Ships as Evidence of the Migrations of Early Culture," *Jour. Manc. Egy. and Oriental Society;* and *Nature,* November 25, 1915, p. 340; December 16, 1915, and January 27, 1916, *inter alia.*

amongst most intelligent men until Waitz, Bastian, Tylor, and their innumerable recent disciples, obscured the clear meaning of the facts by a cloud of empty sophistry and misapplied Herbartian philosophy. In many other branches of learning, such as archeology, philology and the history of many of the arts, numerous scholars, who have escaped the vicious influences of this reactionary school, have continued to rely upon facts and interpret their meaning straightforwardly. The writings of Graebner, Frobenius, Ankermann, Foy, Schmidt and Montandon were quite unknown to me when my conclusions were first formulated; their views and mine have nothing in common except that both repudiate the speculations and the antiquated psychology which for far too long have been permitted to hide the truth.

As a guest at the meeting of the British Association in 1911, when Dr. Rivers devoted his presidential address to the discussion of this matter, Dr. Goldenweiser had every opportunity for appreciating the magnitude of the gap that separated his (Rivers's) views from Graebner's. It is straining the truth to brand Rivers as a recruit of the latter's.

The Graebnerian attitude is largely the outcome of the revulsion of modern German opinion against the whole conception of evolution. It included within the scope of its hostility the method in ethnology which has been misnamed "evolutionary."

But the very essence of the conception of evolution is the derivation of all organisms from a common source. It is the teaching of Bastian and Tylor which is a repudiation of evolution; for it is a much closer approximation to the biological idea to look upon similar complex organizations of a series of artificial civilizations as having been derived from the same common source, just as all vertebrate animals were the offspring of one stock, which, after spreading abroad, became more or less specialized in a distinctive way in each locality. To adopt the attitude, which Dr. Goldenweiser is championing, of regarding as the common parent of all these similar customs and beliefs some mystical "psychic unity" is to place ourselves upon the same mental plane as the aboriginal Australian who believes that children are spirits which have entered their mothers in some mysterious fashion.

But, as he devotes the greater part of his criticism to this matter, I must deal with the specific questions he puts to me.

Dr. Goldenweiser asks me to "name *one* ethnologist who can be shown to have attributed similarities in cultures to the working of highly specialized human instincts." Although every ethnologist who subscribes to the modern Tylorian doctrines necessarily adopts a theory of the working of the human mind which, on analysis, can hardly be differentiated from what the modern psychologist regards as instinct—and an instinct which leads men on the two sides of the Pacific independently the one of the other to look upon a serpent equipped with wings and deer's antlers as a power controlling water can hardly be otherwise defined than as "highly specialized"—very few of them, since the time of Daniel Wilson, have had the frankness to admit a fact which would have branded their speculation as a *reductio ad absurdum*. At the meeting of the British Association in 1912 (see Report, p. 607) I discussed this question, and no one attempted to refute the argument that the adoption by two peoples of highly complex and arbitrary practises along with scores of identical and unessential details can be explained only by the assumption of their (*i. e.*, the customs) derivation from a common source, or by postulating human instincts of so complex a kind that no modern psychologist will admit their reality. Several ethnologists accepted the definition of such phenomena as instinctive. Professor Flinders Petrie made the fantastic claim that there was an instinct to build chambered tumuli which could be explained on biological principles. In a written communication Mr. Cecil Firth argued that if the beaver instinctively built his dam, why shouldn't men for analogous reasons build dolmens? But most of my critics stopped short of admitting that such actions were instinctive, though no one attempted to rebut my argument that the modern ethnological

hypothesis when closely analyzed was tantamount to claiming the existence of highly specialized human instincts. I am, of course, not unaware of the way in which this essential question is usually evaded, by the attempt to explain how similar needs, circumstances and environment, can call forth men's activities and shape them so as to lead to identical cultural developments, quite independently one of the other. But such theorizing inevitably ignores the fact that in the majority of cases such identities of culture actually occur under circumstances and to meet needs as dissimilar as they possibly can be. Whereas of two kindred peoples living under precisely similar circumstances in neighboring islands, say in Indonesia or Melanesia, one of them may possess the whole of the complex culture of the stone-using peoples (Perry), and the other not one of the numerous constituent elements of this exotic civilization. It is when we leave vague speculation and consider specific cases that the so-called "evolutionary" doctrine in ethnology collapses.

The common line of argument is that which is displayed in its frankest form by the late Daniel G. Brinton, and his disciples, such as Spinden and Joyce. In his "Myths of the New World," Brinton writes (pp. 126–127):

> No citizen of the United States will be apt to assert that their instinct led the indigenes of our territory astray when they chose with nigh unanimous consent the great American eagle as that fowl beyond all others proper to typify the supreme control and the most admirable qualities,

and he explains what he means by this in the previous paragraph:

> For the winds, the clouds, producing the thunder, and the changes that take place in the ever-shifting panorama of the sky, the rain-bringers, lords of the seasons, and not this only, but the primary type of the soul, the life, the breath of man and the world, these in their rôle in mythology are second to nothing. Therefore as the symbol of these august powers, as messenger of the gods, and as the embodiment of departed spirits, no one will be surprised if they find the bird figure most prominently in the myths of the red race.

This is rationalization pure and simple, which can be proved to be false in every item. For we are now sufficiently acquainted with the earliest literatures of Egypt, Babylonia and India, to know that the association of the eagle or hawk with all these varied phenomena was not due to the reasons Brinton gives. Every one of these manifold attributes became added to the eagle's repertoire as the result of fortuitous circumstances utterly alien to those assumed by Brinton. The mingling of eagle-people with sun-people, and the association of the latter with serpent-people and with the worshippers of Osiris (the controller of water) was the beginning of the complex blending of the symbolism of the sun, the serpent, the eagle and water. In the Babylonian thunder-bird further attributes were added, and others again in India, the Far East and America.

If the followers of Brinton deny that the American thunder-bird came from the Old World they will be faced with this dilemma: —as the origin of the confusion is known (from the earliest Egyptian writings) to be the result of wholly fortuitous circumstances, if the American symbolism (which arrived at essentially the same arbitrary result—on this see Brinton) was developed in a totally different manner, what becomes of the sacred principle of "psychic unity," the "similarity of the working of the human mind"? I wonder which of the two explanations Dr. Goldenweiser would call the "dogmatic or uncritical method"? To indulge in pure speculation, dogmatic assertion and unsupported rationalization, or to go straight to the facts and recognize that the American thunder-bird and the winged snake with deer's antlers certainly came from the Old World?

We can trace the association of the deer with control of the waters from Babylonia along the whole Asiatic littoral, watching the symbolism gradually increase in richness and complexity as, in its passage from west to east, it blends with a variety of other elements, until eventually it emerges in the Chinese dragon, which it supplies with antlers.[5]

[5] I have discussed the whole subject in the forthcoming report of my lecture on "Dragons and Rain-Gods."

In the light of the complex history and the scores of wholly chance circumstances that contributed to the making of this Asiatic wonder-beast, is it at all credible that the Algonkin and Iroquois serpent with wings and deer's horns is an independent invention?

I have so frequently discussed the question of man's inventiveness[6] that it would be unjustifiable to take up more space for this matter here.

When Dr. Goldenweiser claims that Spencer, Tylor, Lubbock, Frazer and Lang "may have neglected to make sufficient use of the concept of the diffusion of culture through historic contact," I agree with him; but I think the words "may have" are superfluous. Yet American scholars, such as Brinton, Hopkins, Spinden and many others, as well as many writers, such as Keane, on this side of the world, have repeatedly attacked Tylor for *over-using* the concept of diffusion.

It is a quaintly piquant situation to find Tylor, who more than any one is responsible for the modern attitude of denial of these cultural migrations, being reproved by his more reckless followers for not pushing his views to the limits of absurdity, and Dr. Goldenweiser, in a letter that is frankly ultra-Tylorian, pretending to hold the scales impartially between the conflicting views.

It is very surprising that so eminent a scholar as Professor Hopkins joins in this attack on Tylor, especially as he can give no reason in justification of his attitude except the flimsy pretext that "we require more proof than Aztec pictures of hell to believe any such theory" ("Religions of India," p. 557, footnote 4). For the very chapter of Hopkins's book where this statement occurs is devoted mainly to the use of precisely the same kind of argument as he condemns when Tylor uses it. He is urging the claim that Indian culture exerted a great influence upon Greece from the sixth century B.C. onwards. The evidence he makes use of is of precisely the same kind as, but infinitely less voluminous and precise than, that which goes to prove an analogous influence of India in America. He rightly claims that "such coincidences are far too numerous to be the result of chance." But if that is so, why is it forbidden to use the same argument in the case of "the pictures of hell"? Are they the sort of thing two peoples would have independently invented?

But Professor Hopkins goes much further than this. In developing the argument (pp. 161 et seq.) that certain elements of culture in India can not be regarded as tokens of Aryan influence, he cites a very remarkable series of exact coincidences between complex Hindu and Iroquois beliefs and ideas. So intent is he upon the demolition of the Aryan argument that he does not seem to realize the more important outcome of his demonstration. For, if it is permissible to use the method of reasoning which he himself employs in the case of Greek borrowing from India, Hopkins has also proved up to the hilt, though without realizing it himself, the Asiatic derivation of many of the religious ideas of the American Iroquois. To quote his own words again, "such coincidences are far too numerous to be the result of chance."

In the light of our present knowledge it is now possible[7] to refer to its original source the germ of a very large number of the elements in the Pre-Columbian civilization of America.

But I should not like Dr. Goldenweiser to mislead the readers of SCIENCE into the belief that I am ignoring considerations of the working of the human mind and of the importance

[6] See for example "Ships as Evidence of the Migrations of Ancient Culture," *Journal of the Manchester Egyptian and Oriental Society*, 1916; also *Man*, February, 1916, p. 27: and if independent witness is desired, see Pitt-Rivers, "Evolution of Culture," p. 91 *et seq.*; the whole question has been discussed by Professor Frederick J. Teggart, of the University of California, in his admirable "Prolegomena to History," 1916, pp. 111 *et seq.*

[7] I have in manuscript an analysis of many scores of American practises, beliefs and myths, each of them traced back to its home in the Old World. Some of these are now being published in the reports of two lectures, "Incense and Libations" and "Dragons and Rain-Gods," in the *Bulletin* of the John Rylands Library.

of local developments in shaping customs and beliefs and giving them their distinctive characteristics. What I object to on the part of ethnologists is not the use of psychological arguments, which are necessarily at the root of the whole matter, but the resort to an effete system of psychology which is utterly repudiated by practically all real psychologists, except Wundt and his disciples.

When a small band of immigrants, intent upon exploiting the mineral wealth, forces its way into a barbarous country, and, in virtue of its superiority of weapons or of skill and knowledge, is able to dominate the local people, and compel it to work for them, the stamp of the alien civilization, its practises, its customs and beliefs, can be imprinted upon a large servile population. Nor must it be assumed that the new learning is adopted wholly and without change. For every people has its own cherished beliefs and customs which no power can wholly eradicate. What happens in such cases is that the new practises are blended with the old; and in course of time, as the mixture becomes more and more intimately rationalized, a new and distinctive cultural compound is developed, which can not strictly be regarded either as the indigenous or the introduced culture, but a new structure which has been built up by the spirit of the local population out of the new and the old materials. Thus even when the same elements of a new culture are introduced into a series of localities the resultant civilizations are not identical; but each takes on its distinctive characters, which are determined partly by the circumstances under which the new leaven has been impressed, and partly by the nature of the preexisting culture, and possibly to some extent by the character and abilities of the people of the country. For a people's aptitude and inclination to adopt alien practises clearly counts for a good deal in this process. Essentially the same external influences were brought to bear, in varying ways and in different degrees, upon India, Indonesia, Australia, eastern Asia, Oceania and America; but how strikingly different were the results in each of these domains!

The subject, however, is much too vast and intricate profitably to be discussed in a letter. I have already collected enough material for several large volumes on the part played by the "working of the human mind" in the history of civilization. All that I aim at achieving at present is to persuade ethnologists to do what is constantly being done in every *true* science, namely, impartially to examine the foundations upon which its theory rests. If they will consent to do this I have no doubt as to the outcome.[8]

G. Elliot Smith
The University of Manchester, Eng.

THE AMERICAN PHYSIOLOGICAL SOCIETY

The American Physiological Society held its 29th annual meeting in association with the Federation of American Societies for Experimental Biology and the American Association for the Advancement of Science in New York City December 27, 28, 29 and 30. The meetings were all held at the Cornell Medical College buildings where convenient arrangements had been provided also for the other societies of the federation. One of the most pleasant features of the meeting was the arrangement for luncheon, which brought together the members of the different societies.

On December 28 the annual federation banquet was held at the Hotel McAlpin with a large attendance. A similar dinner was held at the Chemist Club December 29.

The new members elected to the society were:

William T. Bovie, Harvard Medical School, Boston.
William John Crozier, Bermuda Biological Station for Research, Agars Island, Bermuda.
Admont H. Clark, Johns Hopkins Medical School.
Frank A. Hartman, University of Toronto.
S. H. Hurwitz, Hooper Foundation, San Francisco.
R. W. Keeton, Northwestern University.
Edward C. Kendall, Mayo Clinic, Rochester, Minn.
Charles E. King, University of North Dakota.
Dean de Witt Lewis, Rush Medical College.
David I. Macht, Johns Hopkins Medical School.
Frank C. Mann, Mayo Clinic, Rochester, Minn.
Victor C. Myers, New York Post-graduate Hospital Medical School.
Oscar H. Plant, University of Pennsylvania.

[8] I think it is only right that your readers should be informed that my article in Science, August 11, 1916, was written in May, 1915, and that by a careless mistake, the uncorrected stenographer's copy was sent to you.

W. C. Quinby, Harvard Medical School.
J. M. Rogoff, Western Reserve Medical School.
C. L. Von Hess, University of Chicago.
Rosaline Wulzen, University of California.

The program of scientific papers and demonstrations was as follows:

IN MEMORIAM

Isaac Ott, A.M., M.D., by Albert P. Brubaker.

Joseph Hoeing Kastle, Ph.D., by A. S. Loevenhart.

Allen M. Cleghorn, M.D., C.M., by Shepherd Ivory Franz.

Thomas Gregor Brodie, M.D., F.R.S., by A. B. Macallum.

"The Fate of Intravenously Injected Dextrose," by J. J. R. Macleod.

"The Diastatic Activity of the Blood in Diabetics," by V. C. Myers and J. A. Killian (by invitation).

"Observations Concerning Fat Feeding," by F. M. Allen (by invitation).

"The Cause of the Increased Heat Production following Pancreatectomy in the Dog," by J. R. Murlin.

"The Use of Cotton Seed as a Food," by Thomas B. Osborne and Lafayette B. Mendel.

"Primary Scrotal Syphilis of the Rabbit and its Utilization in Chemotherapeutic Experiments," by W. H. Brown and L. Pearce (with lantern demonstration).

"The Action of Some Optic Isomers on the Ureter," by D. I. Macht.

"The Influence of Certain Conditions on the Rate at which Epinephrin is Liberated from the Adrenals into the Blood," by G. N. Stewart and J. M. Rogoff (by invitation).

"The Blood Lipoids in Nephritis," by W. R. Bloor.

"Concerning the Lipoids of the Blood in Renal Conditions, with Special Reference to the Cholesterol Content," by Albert A. Epstein and Marcus A. Rothchild (by invitation).

"Observations of Acid Base Equilibrium in the Blood," by John Howland and W. McKim Marriott.

"The Inorganic Composition of Thoracic Duct Lymph," by A. B. Macallum. (Read by title.)

"The Movements of the Artery within the Compression Chamber During Indirect Estimations of the Blood Pressure," by Joseph Erlanger.

"The Time Relations of the Fundamental Heart Sounds," by Carl J. Wiggers and A. Dean, Jr. (by invitation).

"The Veno-pressor Mechanism," by Yandell Henderson.

"Further Observations on the Distribution of Blood in Shock," by H. C. Jackson and H. H. Janeway (by invitation). (Read by title.)

"The Effect of Pneumothorax in the Dog and Cat," by H. C. Jackson and C. J. Imperatori (by invitation).

"A Comparison of the Effects of Food and of Caffeine on Work in the Athlete and an Untrained Subject," by C. B. Root (by invitation) and H. Curl (by invitation). (Read by title.)

"Effects of Physical Training on Pulse and Blood Pressures During Activity and During Rest," by Percy M. Dawson.

"Some Electrical Phenomena of Animal Tissues," by Robert A. Gesell.

"Experiments on the Relation of Blood Pressure to Urine Formation," by A. N. Richards and O. H. Plant (by invitation).

"The Fate of Sulphophenolphthalein when Injected into the Animal Organism: Factors other than the Kidney Influencing its Retention," by E. C. Kendall (by invitation).

"Action of the Diuretics on the Denervated Kidney," by Wm. C. Quinby (by invitation).

"On the Movements of the Isolated Ureter of the Dog," by George B. Roth.

"The Stimulating Action of the Bromide Ion on Smooth Muscle," by T. K. Kruse (by invitation).

"The Physiology of the Chromatophores of Fishes—II. Responses to Alkaline Earths and to Certain Neutral Combinations of Electrolytes," by R. A. Spaeth.

"The Absorption of Fat in Depancreatized Dogs," by Joseph H. Pratt, C. W. McClure (by invitation) and Beth Vincent (by invitation).

"On the Toxemia of Intestinal Obstruction," by L. R. Dragstedt (by invitation), W. Burby (by invitation) and A. J. Carlson.

"The Visible Structure of Cell Protoplasm, and Death Changes," by Robert Chambers, Jr. (by invitation).

"The Effect of a-Amino Acids, Dipeptids and Peptones on the Growth of Cells in Vitro," by Clarence A. Neyman (by invitation) and Montrose E. Burrows (by invitation).

"Muscular Irritability," by C. C. Guthrie.

"Studies in Muscular Power and Fatigue," by A. H. Ryan and J. H. Agnew (by invitation).

"A Comparison of the Amount of Catalase in the Muscles of Active and Inactive Animals," by W. E. Burge. (Read by title.)

"A Study of the Total and Preformed Creatinin in Various Muscles of the Cat," by Ernest L. Scott and Adelaide Spohn (by invitation).

"The Cardio-skeletal Quotient," by W. L. Mendenhall.

"Hunger and Appetite in Fever," by A. J. Carlson, J. Mayer (by invitation) and J. R. Rupp (by invitation).

"The Influence of Temperature on the Gastric Hunger Contractions of Some of the Lower Animals," by T. L. Patterson.

"The Mechanism of the Regulation of the Intra-abdominal Pressure," by Helen C. Coombs (by invitation).

"Preliminary Report of Cardiogram and Blood Pressure Records, showing the Effect of Music," by Ida Henrietta Hyde. (Read by title.)

"Further Observations on the Existence of a Cerebral Heat Center," by Ernest Sachs and P. P. Green (by invitation).

"An Application of Boyle's Law and Avogadro's Hypothesis to the Oscillations of the Mercury Manometer," by Albert M. Bleile (by invitation).

"The Action of an Oxidizing Substance on the Catalase Value of the Blood," by Aaron Arkin.

"The Hydrolytic Products of Chitin," by S. Morgulis. (Read by title.)

"Water Vaporization in Health and Disease," by Eugene F. Du Bois and G. F. Soderstrom (by invitation).

"Some Considerations of the Isolated Bone Marrow," by Cecil K. Drinker, Henry A. Kreutzman (by invitation), and John R. Paul (by invitation).

"Some Physiological Disturbances Induced in Animals by Nitrobenzol Fumigation," by Melvin Dresbach and W. L. Chandler (by invitation).

"Physiological Effects of Ingestion of Ethyl Alcohol by Rectum, with Special Reference to the Gaseous Exchange," by T. M. Carpenter.

"On the Reflex Control of the Vagus Tonus," by F. T. Rogers (by invitation).

"An Instance of Apparent Anesthesia of a Solution," by E. N. Harvey.

"Labyrinthine Reactions in Kittens, with Demonstration," by A. L. Prince.

"Minimal Variations in Spinal Reflex Thresholds," by Eugene L. Porter.

"Possible Periodic Variations in the Knee Jerk in Women," by Jessie L. King.

"The Combination of Thrombin by the Antithrombin of the Blood Serum," by H. S. Gasser.

"The Transformation of the Plasma Clot," by George A. Baitsell. (Read by title.)

"Inhibitory Effects of Adrenalin upon the Sphincter of the Iris," by Don R. Joseph.

"Changes in the Percentage Composition of Muscle Protoplasm during Prolonged Fasting with Work," by C. W. Greene.

"Some Observations on the Conditions of Activity in the Adrenal Glands," by W. B. Cannon and H. F. Pierce (by invitation).

"Further Studies on the Effects of Adrenalin on Muscular Fatigue and Limb Circulation," by Chas. M. Gruber.

"Anti-Neuritic Substances from Egg Yolk," by H. Steenbock.

"Endermic Reactions," by J. D. Pilcher and T. Sollman.

"The Active Constituent of the Thyroid; Its Isolation, Chemical Properties, and Physiological Activity," by E. C. Kendall (with lantern demonstration).

"On the Mechanism of Blood Coagulation," by G. H. A. Clowes.

"The Perfusion of the Mammalian Medulla: The Effect of Carbon Dioxide and other Substances on the Respiratory and Cardiovascular Centers," by D. R. Hooker and D. W. Wilson.

"Recovery Experiments Following Removal of the His Auricular Node in the Dog's Heart," by J. A. E. Eyster and W. J. Meek.

"The Effects of Temperature Change on Rhythm in the Human Electromyogram," by Alexander Forbes and W. C. Rapleye (by invitation).

"The So-called Experimental Streptococcic Poliomyelitis," by C. G. Bull (by invitation) (with lantern demonstration).

"Experimental Studies in Poliomyelitis," by E. C. Rosenow and G. W. Wheeler (by invitation).

"Experimental Poliomyelitis in the Monkey," by E. C. Rosenow and E. B. Towne (by invitation).

"The Relation of the Velocity of the Pulse Wave to Blood Pressure," by Percy M. Dawson. (Read by title.)

"Does the Myelin Sheath Function as an Insulator Broken only at the Nodes of Ranvier?" by J. F. McClendon. (Read by title.)

"The Oxygen Pressure Necessary for Cellular Activity," by Montrose T. Burrows (by invitation). (Read by title.)

"The Cause of Cataract," by W. E. Burge. (Read by title.)

"The Attenuation of the Toxic Action of KSCN by Elevated Temperature," by R. A. Spaeth. (Read by title.)

"A Signal Magnet which Writes Either Upwards or Downwards," by W. Hale.

"Some New Apparatus," by D. E. Jackson.

"An Improved Lever for Frog's Heart and Muscle Strips," by A. H. Ryan.

"The Inhibitory Effect of Stimulation of the Central End of the Vagus Nerve upon the Contractions of an Active Expiratory Muscle in the Chicken," by A. L. Meyer (by invitation).

"Demonstration of a Gas-Analysis Apparatus," by Yandell Henderson.

"The Motion Picture as an Aid in Teaching Physiology," by J. A. E. Eyster and W. J. Meek.

"Pathescope Films used to Illustrate Physiological Demonstrations to Students," by Alexander Forbes.

"Motor Phenomena of the Stomach and Cap as Observed Roentgenographically," by Gregory Cole (by invitation).

"Photographs Representing the Growth of Chickens Fed with Definite Mixtures of Foodstuffs under Laboratory Conditions which have heretofore not Led to Success," by Thomas B. Osborne and Lafayette B. Mendel.

"A Convenient Form of Non-Polarizable Electrode for Class Use," by Theodore Hough.

"Microscopic Demonstration of Absence of Chromatolytic Change in the Central Nervous System of the Woodchuck (*Marmota monax*)," by A. T. Rasmussen (by invitation) and J. A. Myers (by invitation).

"Glycogen in the Blood Vessels of the Liver," by G. Carl Huber and J. J. R. Macleod.

"A Method of Recording Fundamental Heart Sounds Directly from the Heart," by Carl J. Wiggers and A. Dean, Jr. (by invitation).

"Exhibit of Photographically Recording Apparatus for Studying the Dynamics of the Circulation," by Carl J. Wiggers.

The final joint meeting of Saturday afternoon proved to be of unusual interest, especially as regards a group of papers on the subject of poliomyelitis, or infantile paralysis. This discussion brought out the largest attendance of the entire scientific series of meetings.

The annual session adjourned with very kindly feelings of the membership for the local committee and the staff of the Cornell Medical College for the convenient and genial arrangements providing for the physical comforts of the session.

CHAS. W. GREENE,
Secretary

COLUMBIA, MO.

SCIENCE

FRIDAY, MARCH 16, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE STATE GEOLOGIST AND CONSERVATION[1]

BY conservation now-a-days is meant the best use of our natural resources, without waste. Probably the responsibility of conservation rests more upon the state geologist than any other state official, because he is the one, more than any other, whose duty it is to study and inform the public upon the occurrence, quality, quantity and uses of the natural resources of the state he serves.

INEXHAUSTIBLE RESOURCES

Natural resources may be divided into two kinds: Those that are inexhaustible and those that are exhaustible. Of the former are such as sand, clay, road materials, building stone and water power. But while these and others are inexhaustible in quantity, they do not occur universally, so may become, and in most places do become, products upon which it is vitally important that the public be informed.

Here it might be well to call attention to the fact that geologists somewhat, and the public to a large extent, lose sight of the common things, in their anxiety to discover and develop the rare ones. Often a bed of shale for brick making, sand for building, gravel for concrete, or limestone for cement, fertilizer, or other purposes, is of more local importance than a bed of coal, iron ore, or some other of the less common products. A bluff of stone may stand unused for years, before some one will see its value, perhaps for railroad ballast or con-

[1] Read before the American Mining Congress, Chicago, November 16, 1916.

crete work, and not only realize from it a fortune himself, but supply a needed commodity to industry. In studying these inexhaustible materials, as well as the exhaustible ones, the state geologist must consider their quantity and quality, and the possible uses to which they can be put.

This involves such things as the conditions of supply and demand; mining or quarrying; transportation facilities for getting out the raw material, and those of converting it into the manufactured product; and such other things as bear upon its profitable utilization. The state geologist must carefully determine whether on the whole these conditions are favorable or unfavorable, for his conclusion may decide whether or not a deposit that can be worked with profit will be used at once or left unused for many years to come. It is sometimes tempting for the geologist, whether acting as an official for the public or an expert for a company, in those cases where he is doubtful as to the value of a deposit, to take the easiest way out and report unfavorably. May it not be that good property is often thus condemned? Should we not, when placed where we must pass judgment upon deposits of doubtful value, intensify our investigations to the limit of time and means and make sure of our ground, if possible? If the value can not be determined with certainty, then the favorable and unfavorable features should be fully presented.

EXHAUSTIBLE RESOURCES

In studying the exhaustible materials, the state geologist has a double duty. In the first place, it is a part of his work to make known the areas in which such actually, probably or possibly occur, to indicate their quality and character, and to make suggestions as to their development. This part of the state geologist's work has been heretofore and is yet considered his main duty. But with the probability of some of our most important products becoming exhausted in the not distant future, the geologist's duty in conserving known material is next in importance to discovering what is unknown. To this end, he should exercise the powers of his office to prevent waste of exhaustible raw material of all kinds. For example, if there is no other bureau whose duty it is to see that the least amount of coal consistent with good mining is left in the ground as pillars, etc., it plainly is the duty of the state geologist to exert himself toward bringing about mining methods by which the largest possible amount can be recovered. The same line of action will apply to oil, natural gas, the metalliferous ores, and all other exhaustible material.

Again, the state geologist should, at least to a reasonable degree, be alive to the use of by-products. This, to be sure, will take him into the field of metallurgy and chemistry, but most geologists are informed on the elements of these subjects, if they are not experts in them. We can hardly remain unconcerned and permit by-products to be wasted, on the assumption that those operating the mines should employ experts to get the most out of the raw material. If the experts are not employed, the duty of the geologist becomes all the more incumbent, for the loss, while one to the operating company, may be primarily one to the public. It may mean the waste of valuable material the public can ill afford to spare.

Recently there has been impressed upon me the lesson that it is a duty of the state geologist to look carefully into developed mines, not only to ascertain if there is not a waste of the ore for which the mine is worked, or of some possible by-product, but of material that is too important to be classed as a by-product. In the case of the

Embreeville iron mines of Tennessee, mines that have been operated intermittently for something like seventy years, it appears that there have been wasted during all that time, large quantities of zinc ore, the presence of which was only recently discovered by an employee of the mining company now owning the property. This has, during all these years, been mined with the iron, dumped with it into the furnace, and driven off as volatile matter into the air. It is not at all improbable that the value of the zinc thus wasted is greater than that of the iron recovered. For this mine has proved to contain large deposits of zinc, and is now worked for zinc, with iron as a by-product. The mines at Leadville, Colorado, have had a similar history. It is as necessary to keep our eyes open in a developed mine as on unprospected ground.

SOIL AND TIMBER CONSERVATION

While this congress does not immediately concern itself with soil conservation, the title of this paper requires me to say that in those states that are subject to rapid erosion, there is no more important duty of the state geologist than to reduce the waste from soil wash to the minimum. No one knows so well as he, the slow process of soil formation, and the rapid rate at which the hillside accumulations of many thousands of years are removed by uncontrolled running water. The education of those who till the soil to the great importance of preserving it from wash is an overwhelmingly discouraging undertaking, but notwithstanding one which we can not shirk.

In the conservation of our resources, the state geologist, possibly above all others, should look into the future and be controlled by its prospective demands. Our rapidly increasing population; the near occupancy of all our farming and pastoral lands; the possible, even probable, depletion of the soils, natural fuels and useful minerals; all these should have his most serious attention. In those states where forestry legally comes within the duties of the state geologist, an additional responsibility of the greatest importance and one that often requires much diplomacy, is placed upon him.

LEGISLATION AND CONSERVATION

The comprehensive efforts of the state geologist for conservation ultimately require him to do what he can for constructive statesmanship. It is best to attempt conservation through the education of those who earn their livelihood from our natural resources, but at times it becomes necessary to supplement this by legislative enactment. This does not of necessity mean that those engaged in placing natural products on the market are vandals, or even that they are indifferent to waste of material. Among our most ardent and practical conservationists at present are men engaged in farming, mining and lumbering. The necessity for legislation may, and often does, mean that the complete and economic utilization of a natural resource requires conformation to a broad and well-worked-out plan that must be put in operation in statewide, or it may be inter-state, proportions. In such cases, it becomes incumbent upon the state or the nation to impose such restrictions as are consistent with the most complete utilization of such product, the rights of the public, and fairness to capital.

Of such nature is the problem of water-power development in the states that possess it in large amount. This is a natural resource, the future importance of which probably the most sanguine do not realize. There are two ways of having it developed. One is the haphazard way, by which any power site can be occupied without regard to whether the available power is all util-

ized or not, without regard to whether or not it can advantageously be linked up with other sites on the same or neighboring streams, or without regard to where transmission lines go. This means the future non-utilization of a great deal of energy that will be sorely needed. The other is the systematic plan, by which all these things are worked out in detail. This means the ultimate utilization of most of the available water power, and this can be secured only by the assistance of the state through legislative enactment. As all with experience know, this is so difficult that it is well-nigh hopeless. Likewise, conservation of forests, fuel supply and possibly the soil, need to be encouraged by legislative enactment. In part or all of these, depending upon the scope of his duties as defined by statute, the state geologist is expected to take the initiative, by deliberately calling the attention of those charged with administrative and legislative affairs to those resources which the state can aid in conserving.

THE SCIENTIFIC SPIRIT

The object of most legislators in supporting geological surveys is to develop the natural resources; that is, to increase the wealth of the state. We have no fault to find with this attitude, and we willingly exert our energies to that end; but geological work, whether for economic or scientific purposes, requires the strictly scientific spirit as its impelling force, without which no results can be relied upon. For this reason we must ask the public to indulge us if, occasionally, a bulletin appears that does not seem to have economic importance. Such may in the end prove to be of the greatest economic value. The state geologist should be a man who can make his work practical, but he should at the same time be a scientist with irresistible inclinations toward the purely scientific problems that confront him. Only such a geologist can effectually serve a state.

A. H. PURDUE

STATE GEOLOGICAL SURVEY,
NASHVILLE, TENN.

STANFORD MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE second annual meeting of the Pacific Division of the American Association for the Advancement of Science will be held at Leland Stanford Junior University during the period, April 4 to 7.

General Sessions.—Among the general sessions of the division on this occasion will be the address of the retiring president of the division, Dr. J. C. Branner, president emeritus of Leland Stanford Junior University, on the evening of Thursday, April 5. Dr. F. J. E. Woodbridge, professor of philosophy at Columbia University and lecturer in philosophy on the Mills Foundation at the University of California this spring, will present an address on Friday evening, April 6, on the subject, "History and Evolution." This address will be followed by a general reception on the part of the university to the visiting members of the American Association and of affiliated societies.

On Thursday afternoon, April 5, a symposium will be held upon the general subject, "Coordination and Cooperation in Research and in Applications of Science," under the direction of Dr. D. T. MacDougal, director of the Desert Laboratory of the Carnegie Institution of Washington, at Tucson. Among the speakers at this symposium will be Dr. William E. Ritter, director of the Scripps Institution for Biological Research, at La Jolla, who will present a paper on "Closer Organization of Scientific Men of the World."

Meetings of Societies.—The following announcements are made concerning the meetings of societies participating in this occasion.

On Saturday evening, April 7, a dinner will

be given in San Francisco under the auspices of the California Academy of Sciences, at which the visiting members of the American Association and of affiliated societies will be welcome. The president of the academy, Mr. C. E. Grunsky, of San Francisco, will preside, and a number of men of science in various fields of investigation have been invited to give informal addresses.

The Astronomical Society of the Pacific will hold sessions on Thursday and Friday, April 5 and 6. Some twenty papers are expected from the staff members of the Lick Observatory, the Mount Wilson Solar Observatory, the department of astronomy at the University of California, and from others. A feature of especial interest will be a paper by Dr. George E. Hale, director of the Mount Wilson Solar Observatory, covering many details of the investigational work being carried on at this observatory, illustrated with motion pictures.

The Pacific Section of the American Mathematical Society will hold sessions on Saturday, April 7.

The American Physical Society will hold sessions on Saturday, April 7, and a dinner for physicists will be arranged at Stanford University for Saturday evening.

The California Section of the American Chemical Society will hold sessions on Saturday, April 7.

The Cordilleran Section of the Geological Society of America will hold sessions on Thursday and Friday, April 5 and 6. Certain of the sessions will be correlated with those of the Seismological Society of America, and of the Pacific Coast Branch of the Paleontological Society of America, which will also meet upon the same days. The program of the Seismological Society will include a paper by Dr. H. O. Wood, of the Hawaiian Volcano Observatory, on "The Earthquake Problem in Western United States," and a paper by Mr. A. H. Palmer, of the United States Weather Bureau, San Francisco, on "Earthquakes in California in 1916." An extensive program for the Paleontological Society is in preparation dealing with Tertiary faunas of the Pacific coast and the influence of climate upon certain of these faunas.

The Le Conte Club will hold its customary dinner for geologists, paleontologists, geographers and seismologists on the evening of Friday, April 6.

The Western Society of Naturalists will hold sessions on Friday, April 6. Contributions from members of the society will occupy the morning session of Friday and the afternoon session will be devoted to a group of special papers upon the general topic, "The Present-Day Bases for the Evolution Theory."

On Saturday, April 7, an excursion will be conducted, under the auspices of the Zoological Field Club of Stanford University, to the recently completed bungalow of this club in the Coast Range foothills, which all visiting members of the biological societies participating in this meeting are cordially invited to attend. Members of the Cooper Ornithological Club will also join in this excursion.

The Pacific Slope Branch of the American Association of Economic Entomologists will hold sessions on Thursday and Friday, April 5 and 6.

Headquarters and Registration.—The registration headquarters of the Pacific Division for this meeting will be in the rotunda of the zoology building, Stanford University. All those attending sessions of the Stanford meeting, whether members of the American Association or participating societies or not, are requested to register at the headquarters office, and to secure there the general program for the meetings.

Mail and Telegrams.—Mail for persons attending the Stanford meeting should be addressed in care of the American Association for the Advancement of Science, Stanford University, California. Attention is called to the fact that mail should be addressed to the post office known as "Stanford University," and not to Palo Alto, while telegrams should be sent to the Palo Alto office of the Western Union Telegraph Company, marked, "to be delivered at Stanford University, care of the American Association for the Advancement

of Science." Every effort will be made to deliver promptly all mail and telegrams thus addressed to those who have registered.

Election of Officers.—According to the provisions of the constitution of the Pacific Division of the American Association, the election of three members of the executive committee from nominations prepared by a duly appointed nominating committee or received from the floor at the time of election will be held at the evening session of the Pacific Division on Thursday, April 5, preceding the general address of that evening.

Papers and Abstracts.—Those desiring to offer papers at the sessions of any of the participating societies should submit the titles of their papers to the secretaries of their respective societies at as early a date as possible, in order to be accorded a place upon the program. Abstracts limited to 300 words should also be forwarded with the titles of the paper. In case the papers are of a technical nature second abstracts in popular phraseology are requested which may be used in the press reports of the meetings.

Hotel Accommodations.—Rooms may be secured at moderate rates in Encina Hall on the campus of Stanford University by those who wish to stay over night at the university. Applications for lodging should be made in advance to Professor J. P. Mitchell, Stanford University, California. Among hotels in Palo Alto may be mentioned the following:

	Rates per Day, Single Room	European Plan, Double Room
Palo Alto Hotel	$1.00	$1.50
Hotel Larkin, without bath	1.00	1.50
with bath	1.50	2.50

University Hotel, single rooms 50c., 75c. and $1.00.

Railroad Rates.—It has not been possible to make satisfactory arrangements for special railroad rates on the occasion of this meeting. Members are advised to inquire of local agents for round-trip rates which may be in force at the time of the meeting, or to make use of mileage books.

SCIENTIFIC EVENTS

ADVISORY BOARD ON WILD LIFE PROTECTION IN CANADA

THE Canadian government, by an order in council dated December 28, 1916, has appointed an interdepartmental advisory board on life protection for the purpose of formulating plans regarding the protection and use of the wild life—by which term is meant the furbearing and big game mammals, the wild fowl and other animal life—of the northwestern territories, and of advising in the administration of the Northwest Game Act and of the legislation under the recently ratified international treaty for the protection of migratory birds in Canada and the United States, and generally, for the purpose of advising it on questions relating to the protection of and use of wild life in Canada. The advisory board is constituted as follows: James White, assistant to the chairman of the commission of conservation; D. C. Scott, deputy superintendent general of Indian affairs; Dr. C. G. Hewitt, Dominion entomologist; Dr. R. M. Anderson, geological survey; J. B. Harkin, commissioner of Dominion parks.

Mr. James White is chairman and Dr. Hewitt is secretary of the board; Mr. White and Dr. Hewitt are also representatives of the government on the permanent consultative commission for the international protection of nature.

PROFESSOR BLANCHARD ON THE GEOGRAPHY OF FRANCE

DR. RAOUL BLANCHARD, professor of geography at the University of Grenoble, and exchange professor at Harvard University, is now delivering a series of lectures on urban geography. The cities to be considered in this course are: Lyons, Marseilles, Bordeaux, Rouen, Nantes, Nice, Nancy, Lille and Grenoble.

After a careful detailed description of the geography of the region tributary to each city, and of the exact site of the city, Professor Blanchard sketches the history, emphasizing how the geographic conditions in the environs, and the immediate conditions within the boundaries of the city, have influenced the

industrial development. The lectures are very suggestive to American geographers and historians.

Later, Professor Blanchard will give a series of lectures on the geography of the French Alps, and, if time permits, will speak on the geographic factors which have influenced the European war. These lectures are given under the auspices of the department of geography, and members of the profession are welcome as guests.

Professor Blanchard is giving the following lectures in the Lowell Institute series at 5 P.M., in Huntington Hall, Boston:

March 13. "Battle of Charleroi and Morhange."

March 16. "Battle of the Marne."

March 20. "Fixation of the Front: Aisne, Yser, Ypres, Artois, Champagne."

March 23. "Battle of Verdun."

March 27. "Battle of the Somme."

March 30. "Evolution of the Tactics and Armaments from August, 1914, to December, 1916."

THE HAYDEN MEMORIAL AWARD

AT the last meeting of the Academy of Natural Sciences of Philadelphia the gold Hayden Memorial Geological Medal was, on the recommendation of the council and the special committee on the award, of which Dr. R. A. F. Penrose, Jr., is chairman, voted to William Morris Davis, Ph.D., emeritus professor of geology in Harvard University, in recognition of his distinguished work in the science of geology. The medal is awarded every third year "for the best publication, exploration, discovery or research in the sciences of geology and paleontology, or in such particular branches thereof as may be designated."

The award as first defined in 1888 took the form of an annual bronze medal and the balance of the income of the fund. The deed of gift was modified in 1900 so as to provide for a gold medal every third year.

The awards so far made are as follows:

James Hall, of Albany, N. Y., 1890.
Edward D. Cope, of Philadelphia, 1891.
Edward Suess, of Vienna, 1892.
Thomas Henry Huxley, of London, 1893.
Gabriel August Daubree, of Paris, 1894.
Karl A. von Zittel, of Munich, 1895.
Giovanni Capellini, of Bologna, 1896.
A. Karpinski, of Petrograd, 1897.
Otto Martin Torell, of Stockholm, 1898.
Gilles Joseph Gustave Dewalque, of Liege, 1899.
Archibald Geikie, of Edinburgh, 1902.
Charles Doolittle Walcott, of Washington, 1905.
John Mason Clarke, of Albany, 1908.
John Casper Branner, of Stanford University, 1911.
Henry Fairfield Osborn, of New York, 1914.
William Morris Davis, of Cambridge, 1917.

COMMITTEES OF THE NATIONAL RESEARCH COUNCIL

THE following committees have been arranged:

Military Committee: Charles D. Walcott, chairman. From the Army: William C. Gorgas, William Crozier, George O. Squier. From the Navy: David W. Taylor, Robert S. Griffin, James D. Gatewood, and Howard E. Coffin, Van H. Manning, Charles F. Marvin, S. W. Stratton.

Research in Educational Institutions: George E. Hale, chairman.

Promotion of Industrial Research: J. J. Carty, chairman.

Nitrate Supply: Arthur A. Noyes, chairman.

Census of Research: S. W. Stratton, chairman.

Chemistry: Marston T. Bogert, chairman. C. L. Alsberg, L. H. Baekeland, A. A. Noyes, W. A. Noyes, T. W. Richards, Julius Stieglitz, W. R. Whitney.

Physics: R. H. Millikan, chairman. J. S. Ames, F. B. Jewett, J. Langmuir, Theodore Lyman, C. E. Mendenhall, Ernest Merritt, M. I. Pupin, S. W. Stratton, Arthur G. Webster.

Astronomy: E. C. Pickering, chairman.

Botany: J. M. Coulter, chairman.

Zoology and Animal Morphology: E. G. Conklin, chairman.

Medicine and Hygiene: V. C. Vaughan, chairman. Frank Billings, Chas. F. Craig, David L. Edsall, Simon Flexner, Frederick P. Gay, John Howland, Reid Hunt, Theodore Janeway, W. W. Keen, Wm. J. Mayo, George W. McCoy, Richard M.

Pearce, Milton J. Rosenau, Edward R. Stitt, Wm. H. Welch, H. Gideon Wells.

Agriculture: Raymond Pearl, chairman. Edwin W. Allen, Carl L. Alsberg, Henry P. Armsby, Eugene Davenport, Edward M. East, L. O. Howard, L. R. Jones, Whitman H. Jordan, Karl F. Kellerman, Jacob G. Lipman, L. B. Mendel, Erwin F. Smith, Theobald Smith, W. J. Spillman, William M. Wheeler.

Physiology: W. B. Cannon, chairman.

Geography: W. M. Davis, chairman.

Geology: John M. Clarke, chairman.

Anthropology: Wm. H. Holmes, chairman.

SCIENTIFIC NOTES AND NEWS

In accepting the resignation of Professor R. C. Carpenter from the faculty of Sibley College, Cornell University, the trustees have adopted the following resolution:

Resolved, that the trustees in accepting the resignation of Professor Carpenter, express their high appreciation of his services to the university for nearly thirty years. As a pioneer in the field of experimental engineering he is held in the highest esteem by all mechanical engineers, and by his writings in this field he has made an assured place for himself in the annals of his profession. As a teacher and investigator he is affectionately remembered by many generations of students and his retirement from the faculty of Sibley College will be viewed with great regret by all of his colleagues.

The portrait of Professor R. D. Salisbury, planned for by his former students, was presented to the University of Chicago on the afternoon of February 8. Dr. T. C. Chamberlin gave a sketch of Professor Salisbury's life, emphasizing his early work as a student and his contribution as a man of research. Professor W. W. Atwood, of Harvard University, spoke in behalf of the students, emphasizing the great work of Professor Salisbury as an educator and formally presented the portrait to the university. Professor Salisbury, at the request of President H. P. Judson, who presided, replied briefly, and on behalf of the university the president accepted the gift.

Dr. Joseph A. Blake, formerly professor of surgery in Columbia University, who has rendered distinguished services at Neuilly and at Ris-Orangis, has accepted an invitation from the French government to become head of the great Doyen Hospital.

The officers of the Illinois State Academy of Science elected for the ensuing year are as follows:

President, Dr. J. C. Hesler, James Millikin University, Decatur.

Vice-president, J. H. Ferris, Joliet.

Treasurer, Professor T. L. Hankinson, Eastern State Normal School, Charleston.

Secretary, Professor J. L. Pricer, State Normal University, Normal.

The following officers of the Chemical Society, London, for 1917–18, have been proposed by the council: *President,* Professor W. Jackson Pope; *New Vice-presidents,* Colonel A. Smithells and Professor Sydney Young; *New Ordinary Members of Council,* Professor H. C. H. Carpenter, Professor A. Findlay, Professor A. Harden and Dr. T. A. Henry.

Mr. F. J. Cheshire has been elected president of the Optical Society, London.

A gold medal has been awarded by the French government to Professor Landouzy for his long and ceaseless study of tuberculosis and means to combat it.

Dr. Roy G. Pearce, formerly assistant professor of physiology, college of medicine, University of Illinois, Chicago, is now a member of the research laboratory of the medical clinic, Lakeside Hospital, Cleveland. Dr. Stanley P. Reiman, formerly resident pathologist, Lakeside Hospital, has been appointed Hanna research fellow in pathology in the school of medicine, Western Reserve University.

Dr. Robert Grant Aitken, astronomer in the Lick Observatory, has been granted by the University of California four months' leave of absence to go to the Atlantic coast to complete arrangements for the publication of his work on the double stars.

Henry Hinds, geologist and acting chief of the section of eastern coal fields of the U. S. Geological Survey, has left the government service temporarily in order to take up private oil work in Costa Rica and neighboring republics.

DR. A. J. CARLSON, professor of physiology in the University of Chicago, read a paper at the February meeting of the Kansas Chapter of Sigma Xi on "The Nature of the Hunger Mechanism."

ON the evening of March 24 Professor Wallace W. Attwood, of Harvard University, will conduct a lecture conference at the Brooklyn Institute of Arts and Sciences on "Gold Mining in Alaska." The lecture will be illustrated.

DR. W. S. COOPER, of the University of Minnesota, gave a lecture on February 23 before the Geographic Society of Chicago on "The Vegetation of the Glaciers of Alaska." On March 23, Professor Robert G. Aitken, of the Lick Observatory, will speak on "The Work of two Mountain Observatories."

MR. A. CASTON CHAPMAN delivered a lecture, entitled "Some Main Lines of Advance in the Domain of Modern Analytical Chemistry," to the Chemical Society, London, on March 15. Dr. Horace T. Brown will lecture on "The Principles of Diffusion: their Analogies and Applications," on May 17.

THE library of the late Professor Hugo Münsterberg has been given to Harvard University by a group of his friends. The library consists of about 10,000 books, reprints, pamphlets, manuscripts, charts and other papers. Among the 3,000 books in the collection are the latest and most valuable ones on experimental and applied psychology, especially those bearing on phases of the subject to which Professor Münsterberg had devoted his time.

GEORGE MASSEE, formerly of the Royal Botanic Garden, Kew, died on February 17, at the age of sixty-seven years.

DR. A. BATTELLI, professor of experimental physics at the University of Pisa and a member of the Italian national legislature, has died at the age of fifty-five years.

DR. FRIEDRICH HAHN, who occupied the chair of geography at Königsberg, has died at the age of sixty-five years.

THE National Canners' Association has offered Harvard University the sum of $20,000 annually for a period of three years to carry on an investigation of food poisoning or so-called ptomaine poisoning, with special reference to canned goods. The offer has been accepted by the university, with the understanding that the investigation shall be conducted and the results thereof published with entire academic freedom. The study will be made at the Medical School under the direction of Dr. M. J. Rosenau, professor of preventive medicine and hygiene. The national research council of the National Academy of Sciences is supervising the investigations on this subject. The advisory committee of the council consists of Professors John J. Abel, of Johns Hopkins University; Reid Hunt, of Harvard University; H. Gideon Wells, of the University of Chicago; Eugene Opie, of Washington University; Lafayette B. Mendel, of Yale University, and Frederick T. Novy, of the University of Michigan.

THE council of the New York Academy of Sciences has voted that because of the unsettled condition of our international affairs the Centennial Celebration, planned for the second week of the coming May, be deferred without date. It was, however, voted that a centennial meeting be held some Monday evening in May at which emphasis will be placed on the history of the academy. The president was authorized to obtain a speaker for this Centennial Meeting; and was requested, in consultation with the other members of the committee on history to prepare a digest of historical data for the occasion.

THE lieutenant-governor of the Punjab laid the foundation stone of the new building of the Society foı Bromoting Scientific Knowledge at Lahore on January 30. The site for the new headquarters of the society has been given by the Lahore municipality and a sum of Rs. 14,000 has been raised by subscription.

THE department of chemistry of the New York City College, of which Professor Charles Baskerville is the head, has announced a series of lectures to be offered during the spring semester. These lectures are open to the public, and will be held on Friday afternoons at three o'clock in the Doremus Lecture Theater, 140th Street and Convent Avenue. The following is the list of lectures. February 16, "From Ore

to Finished Pipe" (illustrated with motion pictures), by Mr. C. F. Roland, New York representative, metallurgical department, National Tube Co. March 2, "New Method for Nitrogen Fixation," experimental, showing utilization of home-made apparatus, by Dr. J. E. Bucher, professor of chemistry, Brown University. March 16, "Chemical Structure and the Biological Function of Tissue Elements," by Dr. P. A. Levene, Rockefeller Institute. March 23, "The Conservation of Pine Forests through the Methods of Chemical Research" (illustrated by specimens and stereopticon), by Dr. Chas. H. Herty, editor of the *Journal of Industrial and Engineering Chemistry*. March 30, "The Getting of Wisdom," by Dr. H. K. Mees, director research department, Eastman Kodak Co. April 13, "Colloids in Pharmacy" (illustrated and experimental), by Dr. John Uri Lloyd, manufacturer, chief chemist, investigator and novelist. April 27, "Some Chemistry of the Tropics" (illustrated from recent observation), by Dr. L. H. Friedburg, professor emeritus of the College of the City of New York.

DR. THOMAS H. HAINES, professor of nervous and mental diseases at Ohio State University, has five months' leave of absence from his work at the university and from the Bureau of Juvenile Research, and is making a state survey of mental defectives in Kentucky. A state commission on the feebleminded was appointed in May, 1916, by Governor Stanley in accordance with a resolution adopted by the General Assembly in March, 1916. Dr. Haines was appointed director of the survey and sent to the commission in Kentucky by the National Committee for Mental Hygiene, and the Rockefeller Foundation, without cost to the state of Kentucky. Kentucky presents a peculiarly fertile field in which to secure social economics in the management of defectives. By the terms of the Pauper Idiot Act, the substance of which has been on the statute books since the second year of the commonwealth, 1793, any person who is proved to be without estate and mentally feeble, to the satisfaction of a jury, and is so certified to the state auditor, may draw annually from the state treasury, through his committee seventy-five dollars for his maintenance. Last year more than twenty-two hundred such pauper idiots cost Kentucky by this means alone $165,000. This method is said to encourage the propagation of the mentally incompetent.

MR. AND MRS. GILBERT H. GROSVENOR have given to the American Association to Promote the Teaching of Speech to the Deaf a trust fund of $5,000 to establish an "Alexander Graham Bell Grosvenor Memorial Fund," in memory of their second son, who died March 6, 1915. In accepting this memorial fund the directors resolved that the income shall be used in paying for the publication and distribution of literature that will help parents to intelligently train and teach deaf children in the home prior to school age, and that every publication paid for from the income of this fund shall bear on the title page an inscription stating that it is a publication of the Alexander Graham Bell Grosvenor Memorial Fund. Following a suggestion from the donors, the directors decided to offer $300, a sum equivalent to the first year's income, for the best essay on the subject of "Teaching and Training Little Deaf Children in the Home." A decision on the essays submitted will shortly be made by the judges, who are Mr. and Mrs. Edmund Lyon, Rochester, N. Y., Dr. and Mrs. A. L. E. Crouter, Mr. Airy, Philadelphia, Pa., and Mr. and Mrs. Gilbert H. Grosvenor, Washington, D. C.

UNIVERSITY AND EDUCATIONAL NEWS

WASHBURN COLLEGE at Topeka, Kansas, has just added $500,000 to its permanent endowment fund. Of this sum $200,000 was contributed by citizens of Topeka, $200,000 consists of contributions secured by President Womer outside of Topeka and $100,000 was given by the General Education Board.

THE University of California is to receive $10,000 as a library endowment by bequest from Horace Davis, president of the university from 1888 to 1890.

IT has been decided to make the erection of new science buildings for the University College of North Wales, Bangor, the North Wales

memorial to men fallen in the war. The cost of the scheme will be £150,000.

WE learn from *Nature* that Mr. D. M. Forbes, who died on December 13 last, has bequeathed to the University of Edinburgh his books relating to the Philippine Islands, and the residue of his property, which, with the property abroad, will amount, it is understood, to about £100,000, for the purposes of education.

THE council of the University of Liverpool has recently received from a donor who desires to remain anonymous a sum of money sufficient partially to endow a chair of geography. The council has felt justified, under the circumstances, in establishing the chair, and a professor will be appointed in a few weeks.

WALTER A. PATRICK, Ph.D. (Göttingen), of Syracuse University, has been appointed associate in chemistry at the Johns Hopkins University. After two years spent in physical chemical research at the Massachusetts Institute of Technology, Dr. Patrick spent a year with Freundlich, at Braunschweig, a year with Zsigmondy at Göttingen and a year as private assistant to Professor Donnan, at University College, London.

DR. HOWARD T. KARSNER, professor of pathology, has been elected secretary of the school of medicine, Western Reserve University. Dr. Russell J. Collins, demonstrator of pharmacology, has resigned because of ill health.

THE University of Cambridge will hereafter grant the degrees of master of letters and master of science for somewhat the same qualifications as the doctorate of philosophy is awarded by German and American universities. A proposal that the degree of doctor of philosophy be awarded was rejected.

DISCUSSION AND CORRESPONDENCE

WHEN IS A FORCE NOT A FORCE?

THE article by Mr. Gordon S. Fulcher in SCIENCE for November 24, 1916, calls attention in a most timely way to the vagueness which characterizes the discussion of the idea of force in most of our modern text-books of physics, but does not make clear just how he would "use force only in the single definite sense implied in the laws of motion." Let us take the following simple case: a ball is attached to a rubber cord, say three feet in length. A person grasps the ball and pulls it with a force F, stretching the rubber cord to a length of five feet. The strain in the cord is produced by the two forces $+F$ and $-F$ acting at the ends of the cord. The third law of motion covers the case.

Now suppose the person swings the ball around his head at the end of the rubber cord until its velocity is great enough to stretch the cord again to a length of five feet. The stress in the cord is the same as before. The question is, what is the nature of the "reaction" which the ball is exerting on the cord to stretch it? It is certainly a "force" F (otherwise the cord would not be stretched as it is), and it is in one sense balancing the equal "action" of the cord on the revolving ball, which we know as centripetal force. Is the "centrifugal force" (inertia-reaction of the ball) in this case a force in the "single definite sense implied in the laws of motion"? Does the third law also cover this case?

We usually define force as that which produces (or tends to produce) a change in the condition of motion of a mass, either in magnitude or in direction. Certainly inertia-reaction might not come under this definition, but undoubtedly our definitions of force are intended to describe ordinary forces—mechanical, magnetic, electrical, etc.—which can do three things: (1) oppose other forces, (2) produce acceleration, and (3) produce deceleration. The force called friction can do only the first and third of these things; it can not produce acceleration (except in indirect ways). Is friction a force in good and regular standing in the "single definite sense implied in the laws of motion"?

Inertia-reaction can do only the first of these three things; it can not, by its very nature, produce either acceleration or deceleration. And yet even while it is opposing the restoring stress in the rubber cord mentioned above, we

call the force exerted by the cord, because it produces centripetal acceleration, an "unbalanced force."

What is the average student to make of it when he is told in one of our best texts that "force is exerted only while the motion is changing," and yet on the next page reads "a locomotive pulling a train with uniform velocity along a level track exerts force" on the train?

Or when in another text he is told that to *every* action there is *always* an equal and contrary action, and is then informed that an *unbalanced force* acting on a mass produces acceleration?

Or when he reads in one of the very best of our first-year texts that "forces always occur in pairs, one of the pair being equal and opposite to the other," and yet is told a little farther on that "by an unbalanced force we mean more push or pull in one direction than the other"?

Why can not we frankly admit that inertia-reaction acts in one respect like a force, and is actually a kind of force, even if we continue to use the term "unbalanced force" in the sense of *a force opposed only by inertia-reaction?* A porter pushing a heavily laden truck at uniform speed feels the reaction due to friction; if the friction suddenly vanished, he would feel the reaction due to the inertia of the truck. He might not know the difference, except that in the latter case he would succeed in giving the truck a small acceleration. But he would doubtless be greatly astonished to learn that in the first case his push was balanced by an equal counter-force, while in the second case his push was an "unbalanced force"!

The writer finds that the clearest (if somewhat tautological) definition of force for the average student is *that which produces motion, change of motion, compression and tension.* Under this definition the inertia-reaction of the ball revolving at the end of the rubber cord is a force, because it produces tension in the cord.

Inertia-reaction can oppose other forces, it can in that sense balance them, but it can not hold them in equilibrium, because a force opposed only by inertia-reaction always produces acceleration, positive or negative, and may for that reason be called an unbalanced force.

If the drawbar pull of a locomotive is 1,000 pounds, and the sum of the opposing forces due to the friction of the wheels, journals, wind, etc., is 600 pounds, we may say that the unbalanced force exerted by the engine on the train is 400 pounds, and this produces acceleration. *But the pull on the drawbar is the same in both directions*—it is manifestly impossible for it to be otherwise—and the backward pull is made up of 600 pounds of frictional forces and 400 pounds of inertia-reaction.

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SCIENTIFIC BOOKS

Diseases of Occupation and Vocational Hygiene. Edited by G. M. Kober and W. C. Hanson. P. Blakiston's Son & Company. Philadelphia, 1916. Octavo. Pp. xxi + 918. \$8.00.

Ten years ago there was no such thing as a science of industrial hygiene in the United States. During the last half of the decade Dr. Alice Hamilton, Dr. G. M. Price, Dr. E. R. Hayhurst, Mr. F. L. Hoffman and others have conducted fundamental and important investigations in this field; the American Association for Labor Legislation has organized an educational campaign which has resulted in unparalleled legislative advances; and during the past two years three good text-books have appeared dealing with the subject —Dr. G. M. Price's "The Modern Factory," Dr. W. Gilman Thompson's "The Occupational Diseases," and the volume under discussion—besides a wealth of monographs on accident prevention and other special phases of the subject.

"Diseases of Occupation and Vocational Hygiene" is the most ambitious of these works, having been prepared under the editorship of Drs. Kober and Hanson by thirty-one American and foreign specialists in various branches. Many of the topics are so treated

as to make noteworthy contributions to the science of industrial hygiene. Dr. T. M. Legge's section on Arsenic Poisoning is the best brief treatment of this subject known to the reviewer. Dr. E. R. Hayhurst's discussion of brass and zinc poisoning, Dr. G. L. Apfelbach's treatment of carbon monoxid poisoning, Dr. Hamilton's review of lead poisoning in the United States and Dr. Louis Casamajor's section on manganese poisoning all embody in compact form original researches of the authors which have been made under American conditions and with such thoroughness as to be of substantial and permanent value. Professor F. S. Lee's chapter on Fatigue and Occupation is a notable contribution to the subject, and Dr. J. T. Bowen's discussion of occupational affections of the skin contains much valuable material. Dr. L. Devoto's account of his famous clinic for occupational diseases at Milan, Professor G. C. Whipple's brief discussion of the use and the fallacies of statistics, and the sections on factory legislation by Mr. John B. Andrews, by the late Professor C. R. Henderson and by Mr. C. H. Crownhart, are deserving of specially favorable mention.

With the virtues of an encyclopedic work prepared by many authors there necessarily goes a certain lack of balance and proportion, aggravated in this case by the somewhat artificial separation of the diseases themselves from their etiology and prophylaxis which leads to the discussion of arsenic poisoning, brass poisoning, etc., in two different places in the book and often by different authors, with some consequent repetition and confusion. The sections on etiology and prophylaxis, as a whole, show a painstaking study of the literature but do not suggest an intimate first-hand contact with the inside of a factory.

Perhaps the most striking evidence of this academic attitude is the small amount of space devoted to dust, ventilation and general factory sanitation as compared with the industrial poisons. The most serious problems of industrial life are accidents and tuberculosis, the industrial poisonings (except plumbism) being by comparison relatively unimportant. Accidents presumably fall outside the scope of this work but certainly industrial tuberculosis does not; yet dust removal and factory ventilation are scantily treated, while pages are devoted to rare intoxications, of interest only as medical curiosities.

Dr. Gilman Thompson's "Occupational Diseases" while preeminently medical in its viewpoint, includes excellent chapters on factory sanitation and dust removal, is in general far better balanced and should prove more valuable for the physician and the average worker in industrial hygiene; Dr. Price's "Modern Factory," while much more elementary and necessarily superficial in certain details, gives by far the clearest picture for beginning students of the entire subject, including accident prevention, and remains the best text-book for social workers, factory superintendents and others who may be interested in the general aspects of the question. "Diseases of Occupation and Vocational Hygiene" contains much material which will make it a valuable reference book for the specialist; but it is not likely to supplant either of the two earlier works, each of which so well fills its special field.

C.-E. A. WINSLOW

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PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE twelfth number of Volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

The Origin of Veins of the Asbestiform Minerals: Stephen Taber, Department of Geology, University of South Carolina. Cross-fiber veins are formed through a process of lateral secretion; the fibrous structure is to be attributed largely to the mechanical limitation of crystal growth through the addition of new material in only one direction.

A New Test of the Subsidence Theory of Coral Reefs: Reginald A. Daly, Department of Geology and Geography, Harvard University. Existing coral reefs are new upgrowths on platforms which have been formed before, and independently of, the reefs. The sub-

marine topography of each reef-platform structure as a whole and the elementary principles of oceanography declare against the assumption that the forms and spatial relations of atoll and barrier reefs are due to the sinking of the earth's crust.

A New Thermometer Scale: Alexander McAdie, Blue Hill Observatory, Harvard University. It is suggested that the absolute zero and the melting point of ice be designated as 0 and 1,000.

On the Immunity Coloration of Some Nudibranchs: W. J. Crozier, Bermuda Biological Station for Research, Agar's Island, Bermuda. The coloration of *Chromodoris zebra* is a metabolic accident, at least in relation to its protection.

Some Effects of the Continued Administration of Alcohol to the Domestic Fowl, with Special Reference to the Progeny: Raymond Pearl. Confirmation of previous calculations that the progeny of alcoholized parentage in poultry, while fewer in numbers, are made up of individuals superior in physiological vigor and that this result is due to a selective action of the alcohol upon the germ-cells.

An Ionization Manometer: O. E. Buckley, Research Laboratory, American Telephone and Telegraph Company and Western Electric Company. Use is made of the ionization of gas by an electron discharge. The range of the apparatus is from 10^{-3} mm. to as low pressures as can be obtained.

Physiological Studies on Rhizophora: Howard H. M. Bowman, Department of Botany, University of Pennsylvania, and Tortugas Laboratory, Carnegie Institution of Washington. The rate of transpiration varies directly with the concentration of the medium in which the Rhizophora plants grow.

On the Hydrogen Ion Concentration of Sea Water, and the Physiological Effects of the Ions on Sea Water: J. F. McClendon, Department of Physiology, University of Minnesota, and Tortugas Laboratory, Carnegie Institution of Washington. It is concluded that OH', $Na^{\cdot}$ and $K^{\cdot}$ increase the permeability of the plasma membrane by causing it to swell and that $Ca^{\cdot\cdot}$, $Mg^{\cdot\cdot}$ and $H^{\cdot}$ (at least on the alkaline side of the isoelectric point) inhibit increase in permeability by inhibiting swelling.

Some Interrelations between Diet, Growth and the Chemical Composition of the Body: Lafayette B. Mendel and Sarah E. Judson, Sheffield Laboratory of Physiological Chemistry, Yale University. Changes in the water, ether extract, and ash content of the body have been determined under various conditions.

Further Study of the Atomic Weight of Lead of Radioactive Origin: Theodore W. Richards and Charles Wadsworth, 3d, Wolcott Gibbs Memorial Laboratory, Harvard University. Atomic weight of four different examples of isotopic lead not hitherto tested was determined, with the results varying from 207.00 to 206.08.

On Some Anomalies in Geographic Distribution of Pacific Coast Mollusca: William Healey Dall, Smithsonian Institution, Washington, D. C. Observations in regard to long-continued studies by the author.

Some Psycho-Physiological Processes as Affected by Alcohol: W. R. Miles, Nutrition Laboratory, Carnegie Institution of Washington. The percentile effects of the ingestion of alcohol upon a related group of processes, such as the patellar reflex latency, lid reflex latency, patellar reflex amplitude, were studied.

The Influence of the Marginal Sense Organs on Metabolic Activity in Cassiopea Xamachana Bigelow: L. R. Cary, Department of Biology, Princeton University, and Department of Marine Biology, Carnegie Institution of Washington. Muscular activity is a relatively unimportant factor in determining the metabolic activity of *Cassiopea.*

New Evidence in Regard to the Instability of Human Types: Franz Boas, Department of Anthropology, Columbia University.

A Revision of the Atomic Weight of Tin: Gregory Paul Baxter and Howard Warner Starkweather, Coolidge Memorial Laboratory, Harvard University. The value $Sn = 118.703$ $(Cl = 35.457)$ is found.

Further Studies of Nerve Conduction in Cassiopea: Alfred Goldsborough Mayer, Department of Marine Biology, Carnegie Institution of Washington.

The Earliest Fresh-Water Arthropods: Charles Schuchert, Peabody Museum, Yale University. If the eurypterids and limulids arose in the fresh water we can explain why they and the terrestrial scorpions do not pass through a crustacean stage. It may well be that the trilobites retaining the nauplius stage do not give rise to these stocks. We may look for this ancestral stock in one still more primitive, which seems to have permanently invaded the rivers of the land either in Proterozoic time or in Walcott's Lipalian time.

Observations upon Tropical Fishes and Inferences from their Adaptive Coloration: W. H. Longley, Goucher College, Baltimore. The observations here presented undermine many speculative explanations of animal coloration in terms of natural selection.

Report of meetings of the National Research Council and of its Executive Committee.

Address by Lieut. Colonel George O. Squier, on Scientific Research for National Defense as Illustrated by the Problems of Aeronautics.

Research Grants from the Trust Funds of the Academy.

Report of the Autumn Meeting.

We may summarize the articles in Volume 2 of the *Proceedings* as follows: Mathematics, 20; Astronomy, 29; Physics and Engineering, 23; Chemistry, 15; Geology and Paleontology, including Mineralogy and Petrology, 33; Botany, 9 (see also Genetics); Zoology, including General Biology, 20 (see also Genetics); Genetics, 10; Physiology and Pathology, 13; Anthropology, 10; Psychology, 4; a total of 186 articles.

The division of these articles between members of the Academy and non-members is 63 and 123, respectively.

The list of institutions which have contributed three or more articles is as follows: Harvard, 31; Carnegie Institution, 29, divided as follows: Solar Observatory 19, Marine Biology 3, Station for Experimental Evolution 3, all other departments 4; University of Chicago, 12; Johns Hopkins University, 11; University of California, 7; Yale University, 7; Princeton University, 5; Maine Agricultural Experiment Station, 5; Brown University, 5; Massachusetts Institute of Technology, 5; U. S. Geological Survey, 4; University of Illinois, 4; Smithsonian Institution, 4; Rockefeller Institution for Medical Research, 4; Observatorio Nacional Argentine, 3.

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NOTES ON METEOROLOGY AND CLIMATOLOGY

EVAPORATION MEASUREMENT

Loss of moisture from plant and animal surfaces and from the soil interests the plant physiologists, plant and animal ecologists, and students in agriculture and forestry; but evaporation from a free water surface appeals to irrigation and hydraulic engineers. On this account, a type of instrument satisfactory to the one group will not meet the requirements of the other. Although the rate of evaporation depends primarily on temperature, wind-velocity, humidity, it is a function of the nature of the atmometer as well. For instance, the size, shape, material and color of the pan, the height of the projecting rim, and sediment, color and depth of the water, and the nature of the evaporating surface, affects strongly the evaporation. This being the case, Dr. B. E. Livingston says:[11]

> The ratio of the rate of the evaporation from one kind of atmometer pan to that from another kind remains constant only for some single set of surrounding conditions. Thus the evaporation rate from any atmometer varies with the relation between the internal complex of conditions (nature of the instrument) and the external complex (the surrounding conditions of the atmosphere). . . . The exposure of several evaporating surfaces must be alike if their readings are to be comparable.

The readings of one instrument, therefore, can not be reduced to terms of another.

Although many evaporation observations of various sorts have been taken in the United States,[12] this lack of comparability prevents

[11] *Mo. Weather Rev.*, 43, pp. 126–131, 1915, "Atmospheric Influence on Evaporation and Its Direct Measurement."

[12] T. Russell, "Depth of Evaporation in the

the construction of an accurate chart using these data. It is pleasing, on this account, that Dr. Livingston is distributing standardized porous clap cup atmometers, and that the Weather Bureau has adopted a standard evaporation tank. For special purposes at a given locality any type of atmometer which fills the need is best. Thus, to determine the evaporation from a reservoir surface, several floating pans are used; for the study of evaporation as affecting plant transpiration, some form of water-impregnated paper or a porous clay surface is to be chosen; and for soil evaporation, a box or pan of moist soil is logical.

The porous clay cup atmometer, first suggested by Babinet in 1848, modified by Livingston, Shive and W. L. Tower and again by Livingston, is, in its present form, a spherical clay cup 50 mm. in diameter or a clay plate 77 mm. in diameter attached to a bottle of distilled water.[13] Capillary attraction keeps the cup full of water; and, when it rains, the water is prevented from entering the instrument by means of an ingenious mercury stopper in a bend of the feeding tube. This instrument is adapted especially to studies of plant and animal evaporation. The effect of the sun can be measured by exposing a black and a white bulb side by side. Frequent standardization is necessary, although washing reduces the need. It can not be operated in freezing weather; but this is no drawback for most plant studies. The atmometer is so compact and inconspicuous that it can be exposed with safety almost anywhere.

The Weather Bureau standard is a galvanized open pan four feet in diameter and ten inches deep, which is kept clean and filled with water to a depth of more than seven inches. The top of the pan is some sixteen inches above the ground. With the evaporating pan go anemometer, rain-gauge, and maximum and minimum thermometers. When set up, the whole station is surrounded with a substantial wire fence. By means of a still well, and a micrometer, the depth of the water is read every day at about 7 A.M. local time. All water surface atmometers are subject to the disadvantages (1) of wind action which changes the form of the surface and may blow some of the water out, (2) of the splash of raindrops, and (3) of the interference of animals, birds and insects. Furthermore, the water caught in the standard eight-inch rain-gauge is not necessarily the same as that caught in the tank. With all these errors, it seems a mistake to carry the refinement of measurement to the thousandth of an inch.[14]

While the results of the porous-cup observations and those from the evaporation pans can not be used together, each in the course of time will yield data sufficient for the construction of the first reasonably accurate evaporation maps of the United States.

United States,'' *Mo. Weather Rev.*, 16, 235–239, 1888. B. E. Livingston, ''A Study of the Relation between Summer Evaporation Intensity and Centers of Plant Distribution in the United States,'' *Plant World*, 14, 205–222, 1911.

[13] Science, N. S., XLI., pp. 872–874, 1915.

[14] Kadel, B. C., ''Instructions for the Installation and Operation of Class 'A' Evaporation Stations,'' Circular L, Instrument division, 1915, W. B. No. 559, 8vo, 26 pp.

EXTENSIONS OF THE WEATHER BUREAU SERVICE

Out of the $81,210 increase in the appropriations for the Weather Bureau for the current fiscal year, $50,000 has been designated for extensions of the service. The largest item, $30,000 is to be applied for the increase in weather reports from the West Indies and Central America. It is probable that some 10 new stations will be established, and that closer cooperation between the Weather Bureau and the meteorological services of Cuba and the British colonies will be effected. If these plans are carried out there will be about twice as many stations in this region reporting twice daily to the Central Office during the hurricane season, June 1 to November 30. The shipping using the Panama Canal will be most benefited. During, and for a few years after the Spanish-American War, the Weather Bureau maintained a service almost as extensive as that now planned.

$10,000 is to be used for more complete organization of the weather observation work

in Alaska. Juneau is to become a regular Weather Bureau station and climatological section center. Not only will the climate of Alaska become more fully known but also it is thought that the general weather and storm forecasts for the United States will be helped.

Another $10,000 is to be used in extending the river and flood and the frost-warning services.

The Weather Bureau has recently announced a new civil service examination designed principally for college graduates who are competent to carry on scientific investigation. The initial salary is $1,260 a year.

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SPECIAL ARTICLES

EXPERIMENTS WITH THE FOUCAULT PENDULUM

1. *Introductory.*—In view of the relatively large angular velocity of the earth, it should be possible to exhibit this rotation by aid of the Foucault pendulum in a few minutes, and this in such a way that reasonably accurate quantitative results may appear. As the pendulum partakes of the rotation of the earth it is not feasible to attach mirrors to the bob, even if this were useful. It is equally clear that the combination of a horizontal pendulum and a Foucault pendulum at its end, or of a large pivoted balance beam with two identical pendulums at its ends will lead to no solution of the problem. In the following note I shall give the results of an optic and of an electric method which I recently had occasion to test and which may interest the reader. A few remarks will also be made on an earth inductor pendulum.

2. *Apparatus.* The question is obviously solved if the swing of the pendulum is regarded with a distant telescope with an ocular micrometer, sighting in the plane of vibration. The equivalent objective result may be obtained if as in Fig. 1, a lens L (not too strong) is placed near the pendulum. The string at rest C is to be at the conjugate focal distance u to the distance v of the screen S from the lens. The string must be strongly illuminated by a Nernst burner N, or sunlight, or the like, and the arc of vibration ab or $cd = D$ must not be so large as to seriously throw the image m of the string at S out of focus. A lens of focal distance of about 60 cm., for a swing D (double amplitude) not larger than 30 cm., does very well. If S is about at 6 meters u will be somewhat short of 70 cm. The pendulum bob should obviously be heavy (3–6 kg.) and the string long (4–5 meters) so that vibration may be slow (period 4 seconds or more), air currents ineffective and observation at S easy.

The vibration is started with the arc ab in the direction of the optical center of L, or otherwise the lens is so placed. In this case the image of the string is stationary at m on the screen. Of course lateral vibration and rotation of the bob around the string as an axis must be scrupulously avoided. This is easily done by letting the bob fall from a lateral hitching cord with one hand after all vibration has been checked by the loose fingers of the other hand, and the image is at m.

The image m soon begins to vibrate right and left more or more fully on the screen S and after the earth has rotated over the angle θ, the point c is replaced by the elongations dd' and the point m has expanded into the elongations at a distance x apart. With a swing of $D = 36$ cm. originally, the distance x increases to nearly 5 cm. in 5 minutes, or about 1 cm. per minute with the dimension of pendulum and lens given above. The rate falls off because the arc D diminishes.

3. *Equation.*—Fig. 1 shows that if θ is the angle of rotation, for the distance x between the elongations at the screen S and the double swing of pendulum $cd = D$, and if the constant $k = u/v$, approximately

$$(1) \qquad \theta' = \frac{u - D/2}{v} \frac{x}{D} = (k - D/2v)x/D,$$

remembering that the angles θ' at c remain small and are initially nearly the same as θ at the center. Furthermore with the same approximation

$$(2) \qquad \theta = \theta'(1 + D/2u) = k(1 - D^2/4u^2)(x/D).$$

Hence after reduction if the rates per hour be dotted

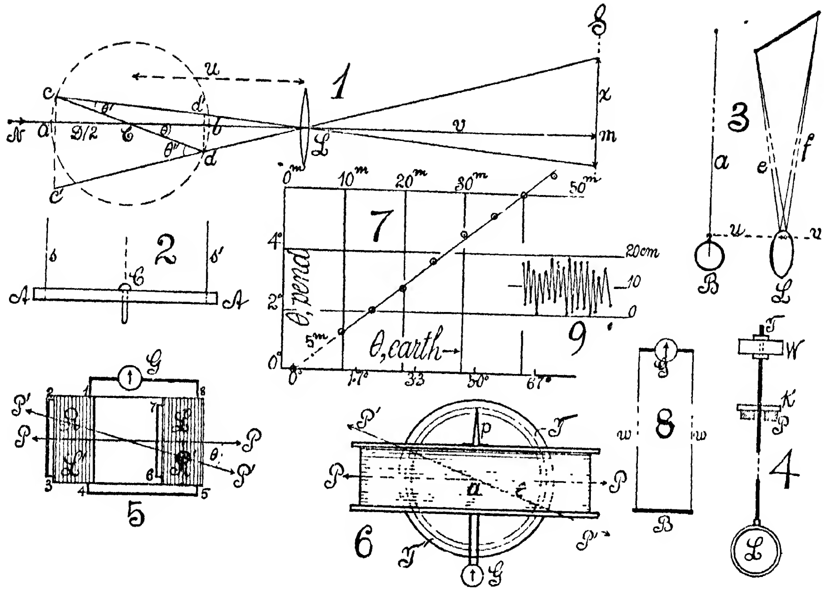

FIG. 1–9

(3) $\dot{\theta} = k\left\{ \left(1 - \frac{D^2}{4u^2}\right)\frac{\dot{x}}{D} - \left(1 + \frac{D^2}{4u^2}\right)\frac{x\dot{D}}{D^2} \right\}.$

The term in $\dot{D}$ increases rapidly.

Another approximation which is perhaps equally good is much simpler. This consists in regarding the angle θ as the mean of θ' and θ'' in Fig. 1; whence

$$\theta = kx/D. \qquad (4)$$

Here k is constant and

$$\dot{\theta} = k\frac{x}{D}\left(\frac{\dot{x}}{x} - \frac{\dot{D}}{D}\right). \qquad (5)$$

Values so obtained are usually too large and increase in the lapse of time, whereas values of equation (3) decrease.

4. *Experimental Reduction.*—The difficulty in correcting the results in x by the equation given makes it desirable to standardize the apparatus directly. This may be easily done by aid of a horizontal arm AA, Fig. 2, carrying two fine vertical wires s, s' at a distance $D = 25$ cm. (average arc above) apart, rotating around an axis C over a graduated circle (not shown). The axis C is to coincide with the string of the pendulum, Fig. 1, and the lens L to correspond as before to the conjugate focal distances u and v. In this way the angle θ is directly determined in terms of x at the screen S, apart from all optic considerations. For the dimensions given, s and s' are adequately focused at S. The data show that within an angle less than 10°, θ may be regarded as proportional to x/D.

This method reproduces the actual conditions under which pendulum observations are made and there seems to be no reason for calling the result in question.

Another method consists in finding the magnification by placing a millimeter scale at C, Fig. 1, and measuring its image x at S.

Both these methods have an advantage, as they admit of reducing the individual x, D values to θ values, without requiring differential coefficients.

5. *Observations.*—The first experiments were made with an ordinary plumb bob somewhat lighter than a pound, swinging from a silk thread over 4 meters long. Fair results were obtained but the light bob is not always trustworthy. An example which must suffice here is given in Table I. for an unnecessarily heavy

pendulum bob (4 kg.), swung from a thin brass wire (diameter .7 mm.). Measurements were continued throughout 35 minutes.

TABLE I

Pendulum Observation

Stationary lens, focal distance 60 cm.; diameter 15 cm. Bob 4 kg. on brass wire. (1) Experimentally $\theta_1 = 1°$ equivalent to $x = 3.8$ cm. for $D = 25$ cm. (2) Experimentally $\frac{1}{2}D\theta_2 = 1$ cm. equivalent to $x = 9$ cm. for $D = 25$ cm.; $K_0 = \frac{u}{v} = \frac{68}{603} = .1144$ $\dot{\theta} = 15° \times \sin \phi = 10.01\ \dot{\theta}^{0/h}$ in Providence.

		D, Cm.	$\dot{\theta}_1$, °/h	$\dot{\theta}_2$, °/h	$\dot{x}$/6 Cm./h	Mean x, Cm.	D/6 Cm./h	Mean D, Cm.	$\dot{\theta}' + \dot{\theta}''$ —
0	1.0	36	—	—					
5	5.8	34	11.2	11.1	8.4	5.2	3.5	3.4	9.2° + .6° = 9.8°
10	9.4	32	10.2	10.1	7.0	9.3	3.5	3.2	8.2 + 1.3 = 9.5°
15	12.8	30	10.2	10.2					
20	15.3	29	9.7	9.7					
25	17.8	27	9.7	9.6					
30	20.1	27	9.3	9.3					
35	22.0	25	9.3	9.3					

$\dot{\theta}_1$ from direct measurement of θ and x.

$\dot{\theta}_2$ from direct measurement of magnification: z at u and x at v. $\dot{\theta}' + \dot{\theta}''$ by the general equation (3) § 3. By equation (5), $\dot{\theta} = 10.4°$ and 9.9°, respectively.

The results for $\dot{\theta}_1$ (computed from the direct evaluation of θ, §4) and for $\dot{\theta}_2$ (computed from direct measurement of magnification §4) are practically identical. These data for $\dot{\theta}$ decrease in the lapse of time, definitely. In part this may be ascribed to an insufficiently accurate estimate of the arc D of the pendulum, for which a value derived from the logarithmic decrement might with advantage have been substituted. The high initial value is in part to be associated with an incorrect initial zero. But it is also probable that some secondary disturbance is developing and superimposed on the data for the earth's rotation.

The value of $\dot{\theta}$ found from the equation (4) is given in the second part of Table I. with the mean data used, for the first four observations taken in pairs. It is of about the same order as the others and also gives promise of decreasing.

6. *The Vibrating Lens Pendulum.*—To increase the magnification indefinitely, *i. e.*, to exhibit the rotation θ in shorter time, it will be necessary to use the lens L, Fig. 3, as the bob of a pendulum, swung doubly bifilarly, or in some similar manner, but in such a way as to have the same period as the Foucault pendulum, B. As the bifilar suspension is still liable to vibrate laterally it is unsuitable for this and other reasons. It was therefore replaced by a massive compound pendulum LT, Fig. 4, about a meter long, weighted above with 1.5 or 2 kilograms to secure as long period as that of the Foucault pendulum (4 seconds). The steel knife edge at K should rest on a horizontal flat brass fork P, as it will be necessary to rotate the pendulum slightly around its longitudinal axis LT in the adjustments. The weights W are between screw bolts to regulate the period. The lens L used was an ordinary photographic bullseye lens, 10 cm. in diameter, quite thick and with a focal distance of about 10 cm. The magnification was between 62 and 65.

As the distance between B and L, Figs. 3 and 4, is but 10 cm. the weights W interfere with the string for large arcs of vibration, D. This would have to be modified in a lecture apparatus, for instance by doubling the lens (condenser doublet) or by forking the weights. Furthermore the vibrations of L die down more rapidly than those of B. Since however the pendulum L is weighted above, there is no difficulty in accelerating the lens L cautiously with the fingers when necessary before observation.

In adjusting the apparatus, B must first be quite at rest. The pendulum L is then started, and if the image of the wire of B vibrates on the screen, the lens L is to be rotated on its longitudinal axis, by successive trials, until the image is stationary. Hence the arc traced by the optical center of L passes through the wire of the Foucault pendulum. B is now to be deflected as above and held until the image of the wire is still fixed in the same place, after which B is released with the two pendulums in step. These operations succeed much easier than would be expected.

The results obtained with this apparatus are essentially exhibitional. Thus far 30-minute intervals if x is the mean arc on the screen s and D the mean swing from which, for the

Time	$\dot{x}/2$	Mean x	D
30 min.	55 cm.	30 cm.	11 cm.
30 min.	60 cm.	50 cm.	10 cm.

magnification 60, the angles $\dot{\theta} = 9.6°$ and $11.5°$ roughly follow. As the x is equivalent to 2 cm. per minute for the swing $D = 10$ cm. this implies 5 cm. per minute for the usual swing of 25 cm. The experiment is therefore striking, but the necessary interferences make it untrustworthy for absolute values of $\dot{\theta}$. Under all circumstances care must be taken that the lens vibrates without displacing the image of the pendulum wire (at rest), both at the beginning and at the end of the experiment.

7. *Electrical Methods.*—The preceding methods are essentially exhibitional, since the measurements are made from images out of focus. It seems possible however that by the use of the following electrical device a method of precision might eventually be evolved, though this is not attempted in the present paper. In all these cases the pendulum bob is a massive cylindrical magnet weighing .8 kg., 20 cm. long and 25 cm. in diameter, with its axis in the prolongation of the string and its north pole downward. The bob is to be additionally and symmetrically weighted. Its arc of vibration is along PP in Figs. 5 and 6. In case of the former four identical coils R, R', L', L, on a wooden core about 5 cm. square were placed symmetrically to the line PP and just below the magnetic bob. The currents induced in R and R' are guided to counteract those in L and L' in an otherwise continuous circuit, so that the galvanometer at G indicates the differential current. If the system $RR'LL'$ is symmetrical to PP the current in G is zero. If PP deviate to PP' the current in RR' will be in excess. The zero may then be restored by rotating $RR'LL'$ until PP and $P'P'$ coincide. This and other methods were tested, but a more elegant design is given in Fig. 6 in which CC is a long coil with strands of wire wound in the direction of the original arc of vibration PP. The coil which I used was about 30 cm. long wound on a square wooden core 5×5 sq. cm. in cross section, with 6 layers of 34 turns each of copper wire .8 mm. in diameter. The terminals of the coil lead to the galvanometer G, an astatic instrument (preferably), with mirror. The coil CC with the pointer p must be capable of revolving around a vertical axis at a, over the fixed graduated circular plate TT for the measurement of the angle θ in standardizing the instrument.

It is obvious that so long as the pendulum vibrates in the plane PP, the induced electromotive force is normal to the strands of wire and the current at G is zero. When the vibration is oblique, along $P'P'$ for instance, there is a component electromotive force along the strands and the current at G increases rapidly with θ. If the period of the needle is about equal to that of the pendulum the arrangement is quite sensitive and an image of a Nernst filament reflected from the mirror of the needle soon oscillates across a distant wall or screen.

To obtain the current zero, the magnetic bob must oscillate strictly in the vertical plane PP. Any cross vibration or elliptic oscillation at once develops marked currents. Moreover in the course of time it is extremely difficult to obviate the development of these cross vibrations. They would arise if the bob rotates around its own axis, since rigorous rotational symmetry is rarely attained. They would also arise in the reaction of induced currents on the magnetic pole.

The following is a typical experiment among many results. A galvanometer with astatic needles was adjusted by aid of three astisizing magnets placed symmetrically below and on the sides of the needle (strengthening the earth's field) until its period was decreased to 4 seconds, nearly identical with that of the pendulum. In view of this relatively strong magnetic field, the needle was practically free from damping resistances. The experiment was very striking, for with an arc of vibration D between 20 cm. and 25 cm., the vibration of the image of a Nernst filament at first ($D = 25$) increased over 3 cm. per minute.

Table 2 and Fig. 7 is an exhibit of the data obtained when the plane of the pendulum vibration passed through the plane of the coils, x changing from negative to positive values. Unfortunately the undamped needle does not stop vibrating when the intensity of the inductive impulse is reduced to zero; otherwise the rotation of the earth might be directly read off at p, Fig. 6, by rotating the coil on a tangent screw. The reduction factor F in $\theta = Fx$ was measured for 3 arcs: At $D = 24$ cm., $\theta = .054°$, at $D = 14$ cm., $\theta = .087°$ and at $D = 8.7$ cm., $\theta = .111°$, corresponded respectively to $x = 1$ cm.

TABLE II

Electrical Pendulum Registry

$\theta = Fx - .5°$ cylindrical magnetic bob, length 20 cm., diam. 2.5 cm., mass 800 grams. Long square coil, 6 layers, 34 turns each, 30 cm. long, 5 cm. broad, 5 cm. high within. Bob and astatic needle of galvanometer with synchronized period of 4 sec.

t, Min.	D, Cm.	$F \times 10^3$	x, Cm.	θ, Deg	°/Hour
0	22	60	—19	—	—
5	19	70	(7)	(.00)	—
10	16	80	16	.78	9.4
15	14	85	24	1.54	9.2
20	13	90	31	2.29	9.2
25	11	100	37	3.20	9.6
30	10	105	44	4.12	9.9
35	9	110	48	4.78	9.6
40	8	115	52	5.48	9.4
45	7	125	53	6.13	8.2

For other arcs D the reduction factor F was interpolated. When x is negative, the arcs x are in excess of the electromotive impulses which are decreasing toward zero. When x is positive the arcs are in deficiency of the increasing impulses due to the rotation of the earth. Hence an undamped needle does not come to rest and in Table II. and Fig. 7, $\theta = 0°$ at $t = 2$ min. was interpolated (parenthesis) from the subsequent 8 data. This makes $\theta = Fx - .5°$, beginning with $t = 5$ min. The fluctuations of $\dot{\theta}$ are due to the rough measurement of D and the correspondingly rough value of the reduction factor F and are quite as good as anticipated. Eventually the decrement of x due to decreasing arc D must begin to approach the increments due to the earth's rotation, whereupon x will be stationary. This seems to happen after 45 m. in Table II.

Again if the reduction factor F of x is taken constant throughout, the results show the rapidity with which the θ values fall off even after 10 minutes. Thus it seems that a compound pendulum on knife edges, Fig. 4, with the magnetic bob similarly placed to the coil must be used for standardization.

In other series experiments the reduction from x to θ was made linearly, the constants being a mean approximation from a direct measurement of x and θ. This however is the real difficulty of the method and is far from satisfactory owing to the development of cross vibrations.

In the final results the case of a core of 4 iron plates (each 18 cm. $\times$ 25 cm. $\times$ .044 cm.) placed symmetrically within the coil was tested. In view of the breadth of these plates and the weight of the pendulum there was supposed to be no danger from induction. The sensitiveness (scale at 4 meters) was thus increased to an initial growth of $x = 5$ cm. per minute of earth rotation. It would have been larger if the periods of pendulum and needle had been as nearly the same as before. Here I found roughly $\theta = Fx = (.110 - .0035D)x$ and it was interesting to note that for the last data the term in Dx had passed through a maximum. Hence the increments of x are much reduced. If the logarithmic decrement is used, $\dot{\theta} = 60(a - bD_0c^{t/5})x$ degrees per hour, follows, where a and b are the constants given, $D = 27$, $c = .896$. Greater smoothness is thus obtained, but the real difficulty which resides in the constants a and b is left untouched. Finally one may note that the data with a plate iron core in the coil were apparently as good as those obtained without; for the correction coefficients which indicate the growth of cross vibrations were actually larger (accidentally) in the absence of iron.

8. *Short Pendulum.*—The endeavor was now made to use the same method for a short pendulum. For this purpose the magnetic cylinder was swung on a round glazed fish line.

To secure an adequate suspension the top of the cord was first passed through a snugly fitting hole in a fixed wire draw-plate and then attached to the shaft of a strong fixed horizontal screw, above. On turning the screw the bob could be raised or lowered at pleasure or secured in any position in virtue of the friction of the screw. An old Kohlrausch galvanometer with elliptic coils and a magnetized steel mirror in a copper damper at its center was found very serviceable. By placing the astisizing magnet in different positions with or against the earth's field, the periods could be usefully varied from 1 second to over 6 seconds.

Pendulums ½ to 1 meter in length were first suspended from a single massive rigid standard; thereafter from a gallows between two massive standards, carefully braced. In neither case was I able to eliminate to development of elliptic vibrations, however, resulting either from the action of the induced currents on the magnetic bob (an effect to be anticipated) or from vibrations at the suspension. I did not therefore attempt to carry out measurements, although from the rapid motion, the sensitiveness was very marked, $\theta = .06°$ to $.03°$ per $x = 1$ cm. being easily available. A rotational effect should therefore be observable in 10 sec. The whole experiment is an interesting one, regarded either in its present bearing, or as an illustration of a vibrating system of two degrees of freedom, or of the laws of induction.

9. *The Bifilar Inductor Pendulum*.—Though not immediately connected with the present subject, the following striking experiment uses similar synchronized apparatus. A long (1–2 meters) brass or copper rod or bob, B, Fig. 8, is swung horizontally from two thin vertical brass wires ww attached at the ends of the rod and to the ceiling, or elsewhere. These thin wires are the terminals of the synchronized galvanometer, G, and the brass rod swings parallel to itself, cutting the earth's vertical magnetic field, H_v, normally. The mean horizontal speed, $\dot{y}$, of the rod may be written in terms of the maximum speed, $\dot{y}_0$ (simple harmonic motion) as $\dot{y} = 2\dot{y}_0/\pi$ and if a is the amplitude of the pendulum, T its period, l its length, g the acceleration of gravity, e is the mean electromotive force induced and b the length of brass rod (bob),

$$e = \frac{2abH_v}{\pi \times 10^8}\sqrt{\frac{g}{c}} \text{ volts.}$$

In my pendulum

$a = 20$ cm., $b = 100$ cm., $H_v = .4$, $l = 400$ cm., whence

$$c = 8 \times 10^{-6} \text{ volts nearly.}$$

Thus it should be possible to measure e with a moderately sensitive galvanometer, particularly so if its period is the same as that of the pendulum.

Incidentally one may observe that if a horizontal wire 10 meters long is moved normally through the earth's vertical field with a speed of 2 kilometers per minute, as on a flying machine, the difference of potential at the ends would be over $e = 10^{-2}$ volts. The latter would have to be measured electrostatically, however, with an artificial earth like a large insulated condenser. If this can be done, it would suggest a method of registering the speed of the machine.

A number of experiments were made with the above pendulum ($T = 4$ seconds) and the synchronized Kohlrausch galvanometer, of which Fig. 9 gives an example. The needle of the galvanometer was not at rest, owing to the proximity of trolley wires and the astasized *simple* needle. Hence the fluctuations at the two elongations. But apart from this, the result is about $x = 7$ cm. between elongations per meter of length of the bob of the bifilar pendulum and a double amplitude of the latter of about $D = 40$ cm. (screen at 4 meters). A shorter pendulum, an astatic needle and an external magnet strengthening the earth's field at the galvanometer, would give smooth results. D could be much increased, etc. It is also obvious that a long rectangular coil similar to the bifilar and on knife edges could be used to multiply the effect of the single bifilar circuit.

CARL BARUS

BROWN UNIVERSITY,
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SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and eighty-ninth regular meeting of the society was held at Columbia University on Saturday, February 24. The morning session sufficed for the presentation of the brief list of papers. The attendance included twenty-six members. Professor H. S. White occupied the chair, being relieved by Professor Kasner. The council announced the election of the following persons to membership in the society: Professor H. P. Kean, McHenry College; Mr. Ralph Keffer, Harvard University; Mr. H. C. M. Morse, Harvard University; Dr. F. D. Murnaghan, Rice Institute; Mr. G. E. Raynor, University of Washington; Dr. S. P. Shugert, University of Pennsylvania; Mr. G. W. Smith, University of Illinois; Mr. J. S. Taylor, University of California; Dr. L. E. Wear, University of Washington; Dr. H. N. Wright, University of California. Four applications for admission to membership were received.

It was decided to hold the next summer meeting of the society at Cleveland, Ohio, on September 4–5. The Mathematical Association of America will meet at Cleveland on September 6–7.

By the will of the late Professor L. L. Conant, of the Worcester Polytechnic Institute, who was a member of the society from 1893 to his death in 1916, the sum of $10,000 is left to the society, subject to Mrs. Conant's life interest. The will provides that the income of this bequest "shall be offered once in five years as a prize for original work in pure mathematics." This generous gift, a noble monument to the donor, should do much for the promotion of higher mathematical aims in this country. For many years the society has consistently pursued these aims, with a success far outrunning what might have been expected from its modest financial resources. With greater means in the way of general or special funds, it could accomplish still more. To anyone who is able to give for science, the society presents itself as an experienced and beneficent administrator.

At the annual meeting, the council placed itself on record as desiring to cooperate with the National Research Council in forwarding the interests of research. At the February meeting a committee was appointed to confer with the chairman of the Mathematics Committee of the Research Council, Professor E. H. Moore, in regard to the selection of the members of that committee.

The following papers were read at this meeting:

A. R. Schweitzer: "The iterative compositions of a function of $n+1$ variables ($n=1, 2, 3 \dots$)."

A. R. Schweitzer: "Functional equations based on iterative compositions."

D. F. Barrow: "An application of Fourier's series to probability."

Edward Kasner: "Degenerate cases in the theory of the conduction of heat."

J. E. Rowe: "The equation of a rational plane cubic derived from its parametric equations (second paper)."

R. L. Moore and J. R. Kline: "The most general closed plane point set through which it is possible to pass a simple continuous plane arc."

H. S. White: "New proof of a theorem of von Staudt and Hurwitz."

Henry Taber: "On the structure of finite continuous groups."

The next meeting of the society will be held at the University of Chicago on April 6–7. The San Francisco Section will meet at Stanford University on April 7.

F. N. COLE,
Secretary

OKLAHOMA ACADEMY OF SCIENCE

THE Oklahoma Academy of Science held its eighth annual meeting in Oklahoma City, December first and second, with President C. N. Gould in the chair. The following papers were presented:

AGRICULTURE

"Effects of Soil Types on the Root Development of Cotton and Kaffir," by Wallace MacFarlane.

ARCHEOLOGY

"Types of Stone Implements," by J. B. Thoburn.

CHEMISTRY

"Errors in the Determination of the Coefficient of Viscosity Gases by the Capillary Method," by I. M. Rapp.

"Sulfur in Petroleum," by Chas. K. Francis.

"Effect of Para Substituents in the Acylation of Aromatic Amines," by L. Chas. Raiford and A. F. Whipple.

"Oxidation of Ethyl Alcohol to Acetaldehyde," by Wm. J. Becker.

"Infra-red Absorption of Naphthalene," by A. H. Stang.

"Visibility Curves of the Green Mercury Line and Its Satellites," by A. F. Reiter.

ECONOMICS

"Setting the Clock Ahead," by Joseph M. Perkins.

"The Lumber Industry of Oklahoma," by John Cullen.

EDUCATION

"The Educational Survey," by T. Earl Sullinger.

"Seeing Oklahoma," by C. W. Shannon.

"The Teaching of Physiography and Geography in Our Common Schools," by C. W. Shannon.

ENGINEERING

"Oklahoma City's New Water Plant," by W. L. Benham.

"Appraisal of Public Utilities" (by title), by A. L. Mullergren.

GEOLOGY

"The Practicality of Using the Diamond Drill in Exploring for Oil and Gas Structures," by Geo. E. Burton.

"New Anticlines," by Chas. N. Gould.

"Concretions in Caddo County," by Chas. N. Gould.

"Origin of the Ferruginous Sandstones of Southeastern Oklahoma," by Chas. W. Honess.

"The Occurrence of Coal in Cimarron County," by Fritz Aurin.

"Progress of Work in the Cretaceous Area of Oklahoma," by C. W. Shannon.

"New Volcanic Ash Theory," by Chas. N. Gould.

"Manganese Deposits Near Bromide, Oklahoma," by Geo. E. Burton.

"The Distribution of the Sand Dunes of Oklahoma," by Bryan Hendon.

"Oil Seeps," by Elbert E. Boylan.

"A 'Gas Blow-out,'" by V. V. Waite.

"The Elephants of Oklahoma" (by title), by E. B. Wilson.

"The Early Vertebrates of Oklahoma" (by title), by M. G. Mehl.

"Granite Situation in North-Central Kansas" (by title), by Everett Carpenter.

MATHEMATICS

"English Experiences in Teaching Calculus to Trades-school Students," by A. Press.

"A Shorter Proof of a Theorem on Fourier's Series" (by title), by W. H. Cramblet.

BIOLOGY

"A Flock of Hawks," by Chas. N. Gould.

"*Platanus occidentalis*," by Chas. N. Gould.

"Past and Future of the Buffalo," by Frank Rush.

"Reproductive Organs of Birds and Their Activities" (by title), by T. C. Carter.

"Biological Significance of Bones, Teeth and Shells Found in the Caves of Eastern Oklahoma," by H. H. Lane.

"Further Observations on the Effect of Acohol on White Mice," by L. B. Nice.

"Speech Development of a Child from Eighteen Months to Six Years," by Mrs. Margaret Morse Nice.

"The Murine Opossum, an Accidental Immigrant in Oklahoma," by H. H. Lane.

"On a Collection of Moths and Butterflies from Costa Rica," by H. H. Lane.

"Some Personal Observations on the Habits of the Butcher's Shrike," by C. W. Shannon.

"Observations on *Demoder folliculorum*" (by title), by G. K. Stanton.

"The Relation of Vegetation to Stratigraphy" (by title), by Floyd Absher.

"The Hawks of Oklahoma" (by title), by Joe Matthews.

The Committee on Publications reported that arrangements had been made whereby the University of Oklahoma would assume responsibility for publishing the proceedings, the academy paying what it can and the state assuming the balance. The report was accepted. The committee appointed on publication for the coming year consists of the president, treasurer, secretary and curator.

The committee on membership presented the names of forty new members which were accepted.

Professor C. W. Shannon, director of the Oklahoma Geological Survey reported that the Biological Survey working in connection with the academy had established many nature study clubs in the public schools of the state during the past year. Report accepted.

A committee was appointed to work to get better laws passed in Oklahoma for the protection of wild life. Mr. Frank Rush, United States forester, in charge of the buffalo herd, in the Washita Mountain Reservation, was made chairman of this committee.

The treasurer's report was read and accepted.

The following officers were elected for the coming year:

President, L. Chas Raiford, A. & M. College; *First Vice-president,* M. M. Wickham, Southeastern State Normal School; *Second Vice-president,* A. F. Reiter, Phillips University; *Treasurer,* H. H. Lane, University of Oklahoma; *Secretary,* L. B. Nice, University of Oklahoma; *Curator,* Fritz Aurin, Oklahoma Geological Survey.

L. B. Nice,
Secretary

SCIENCE

Friday, March 23, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE RELATIONS BETWEEN ENGINEERING AND SCIENCE[1]

We may well approach our subject of the relation between engineering and science by defining these two.

Engineering is the application to man's use of special knowledge of mechanics and of the properties of matter.

Natural science is the correlation of natural phenomena, often combined with their discovery. Emerson says:

> Science is nothing but the finding of analogy, identity in the most remote parts.

This finding of analogy is correlation. But though science has correlation for its essence it also includes discovery. Science thus has two aspects, it correlates the uncorrelated and hence empirically known phenomena, and it discovers new phenomena and correlates them simultaneously. Their correlation is of origin, congenital. Or, if you will not go so far with me, let us agree that engineering is essentially application and science essentially correlation with or without discovery. In this view engineering is not a science but an art with a scientific basis. A man who is an engineer may correlate his own or others' discoveries, as he may walk a mile or pledge a health, but he does it not as an engineer but as simultaneously a natural philosopher.

From this point of view pure science in

[1] Introductory address of the chairman of the Section of Engineering of the American Association for the Advancement of Science given at the meeting held by invitation of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, New York, December 29, 1916.

its relation to engineering seems to-day to be in an intermediate stage of its asymptotic evolution from the state of a follower to that of an absolute dictator. The first reason why this evolution has to follow this general course is that application must needs precede correlation.

Man like the other animals from the very first can survive only as he applies nature's laws to his needs, as he conforms to them, so that he begins applying them inconceivably earlier than he begins to formulate them or even to be capable of formulating them.

The second reason lies in the unfathomable complexity of the laws on which engineering must needs be based.

The engineering of the savage is military. His existence depends on his power to kill his enemies and incidentally his game by means of weapons made from the materials at hand. Of these materials he knows only certain prominent properties irrelated to each other and to the rest of nature. If this knowledge can be said to consist of laws they are only the most minute fragments when compared even with the fragments of laws which we have joined up. They are fragments comminuted to the second degree. The explanation of these fragments the savage has never sought. Yet the laws themselves were as complex when our forefathers were naked as they are to-day. The Bornean or Fiji knows that wood is strong, stone stronger, and iron stronger still, though corruptible by rust. Armed with this and all other knowledge which he has he destroys those who else would destroy him. The survival is not of those who formulate knowledge but of those who best apply it, and so there evolves a race which applies successfully the laws which it may never even think of thinking of.

By and by evolution lifts certain men so far up out of the imperative need of ceaseless viligance lest they be slain by their fellows or by nature as to give them the opportunity to consider their environment, and note the analogies between phenomena which at first seem irrelated. These are the first men of science. Before them the ratio of observed to correlated phenomena was that of a small body to zero, and hence was infinity. With them that ratio fell from infinity to finiteness, but it was still extremely small.

As the accumulation of observed phenomena goes on and with it the organization and elaboration of society, certain men come to excel their fellows sufficiently in their mastery of this knowledge, and in their ingenuity in applying it, to become recognized as a special class, engineers. More slowly the accumulation of observed analogies becomes so great that those who master it become recognized in their turn as a class, the natural philosophers or men of science.

These philosophers address themselves at first to correlating phenomena, which, however familiar, are known as yet only empirically, and thus to explaining that which engineering has long known how to do, has known in part since the days of Assyria, of Homer, and of Kephren. But this is to trail after engineering, to explain its exploits as the minstrel glorifies those of the warrior. By and by science becomes able, through its accumulation of correlations, to point out to the engineer how he may better his service to man. But this is to snatch a share in the leadership, and add it to the continuing labor of correlation.

From this time on science increases continuously the share which it has in the direction of engineering. It is engaged ever more and more in discovering and simultaneously correlating new knowledge, and less and less in the gradually vanishing

work of the correlation of the old empirical knowledge with which alone engineering formerly worked. With the completion of this latter task science might come to be the sole guide of engineering, but for two considerations.

First, as engineering adopts the knowledge which science has correlated it simultaneously unearths new uncorrelated knowledge. Science indeed correlates this in turn, but not instantaneously, so that engineering has always at its hand both that which science has correlated and its own empirical discoveries which science has not yet had time to arrange. As optimists we may well expect that this uncorrelated knowledge will form a gradually decreasing fraction of the whole, but can we expect it ever to vanish completely? Must not science's approach to exclusive leadership be asymptotic?

We begin to get a glimmering of the vastness of the scheme of creation when we remember that every lengthening of man's artificial vision by means of telescope and camera, every new strengthening of telescope, sensitizing of plate, and lengthening of exposure brings a proportional increase in the number of visible suns, telling us that even at that inconceivable distance we have not begun to approach the limit of the discoverable universe. When we turn from telescope to microscope and thence to the inferred constitution of matter, we find with every new refinement of observation and inference a proportional addition of new wonders, a proportional increment in the complexity of natural phenomena. Hence while we may speculate that, as there must be a place where the stars end, so there must be a degree beyond which the subdivision of matter can not go, and a limit to the number of nature's laws, we may well ask whether either that limit or the limit of stellar space will be reached in that little throb in the pulse of the universe which we call the habitable period of this earth. Will man survive long enough to complete the discovery of all laws, so that no uncorrelated phenomena will remain for the engineer to unearth?

The second of the two considerations which tend to postpone the completion of science's leadership is that the beautiful as distinguished from the useful and the good will increase without limit its demands upon the work of the engineer. Though the beautiful itself should in time be capable of complete mathematical analysis, who shall say that that time, now seemingly so inconceivably remote, can arrive during man's earthly stay?

HENRY M. HOWE

OUR PSYCHOLOGICAL ASSOCIATION AND RESEARCH[1]

THE American Psychological Association, like the infants who are among the objects of our study, celebrated its first birthday some months after it was born. We are thus able to hold at the same time our twenty-fifth meeting and mark the completion of nearly twenty-five years of activity. This period covers the working life of most of us and about half the adult life of the science in which we work. Wundt's "Physiologische Psychologie," published in 1874, may be taken to mark the coming of age of the experimental work of Weber, Helmholtz and Fechner. But if psychology as a science was made in Germany, the raw materials were contributed from many nations, many centuries, many sciences; and the leading strings attaching us to Germany were severed at about the time when this association was organized.

[1] Address given on the occasion of the celebration of the twenty-fifth anniversary of the American Psychological Association, New York, December 28, 1916.

Our three great leaders in psychology had made straight the way, James at Harvard, Hall at the Johns Hopkins, Ladd at Yale. The publication of "The Principles of Psychology" in 1890 was a declaration of independence, defining the boundary lines of a new science with unapproachable genius. Simultaneously with the printing of the articles composing James's book, Hall was developing the genetic and educational work in psychology which now occupies such a large place. At that time professorships and laboratories of psychology were established at Clark, Pennsylvania, Harvard, Yale, Wisconsin, Toronto, Cornell, Princeton, Columbia and other universities, and these gave birth to the newer generation now active among us.

Both as significant symbol of the position attained by psychology and as true cause of its further progress, the establishment of the American Psychological Association in 1892 is notable. The American Chemical Society, founded in 1876, was the first of our special scientific societies; it was followed in 1888 by societies of mathematicians and geologists. But our association is among the oldest of the fifty different national organizations now meeting here. The association of those with common interests throughout the nation and the world, so that our neighbors are no longer only or chiefly those living in the same place, is among the most remarkable changes and advances of modern civilization. The social group reacts in much the same way as the local group, there are jealousies, misunderstandings and quarrels, but also respect, friendship and cooperation, and when the group can perform a useful service or is threatened from without it develops a consciousness of kind. Groups of this character, whose individuals are bound together by common interests and objects, may become institutions more dominant over our lives, having greater claims to our loyalty and service, than the conventional family, the helpless church or the blood-stained nation.

Our place of birth was Clark University; the day, July 8, 1892; G. Stanley Hall was our Socrates and mid-wife. The original members numbered twenty-six. It may be worth while to call the roll. Frank Angell, then as now of Stanford University, a lost angel to us, for he is no longer among the fellowship of the saints. J. Mark Baldwin, then of the University of Toronto, whose contributions to psychology have been so notable, also one of the few whose name is absent from our rolls. William Lowe Bryan and Edmund C. Sanford, pioneers in experimental research, now fallen to "that bad eminence," where they bear the load Atlantean of our humbler fates. W. H. Burnham and Bejamin Ives Gilman, the one in a fundamental branch of education, the other in the fine arts, carrying on work somewhat apart from ours, but related to it. William Noyes, recently lost to us, and Edward Cowles, distinguished alienists. Cattell—*adsum*. John Dewey, John the Baptist of democracy, teacher of teachers, modern master of those who know. E. B. Delabarre, then as now at Brown University. W. O. Krohn, then at Clark; Herbert Nichols, then at Harvard; E. W. Scripture, then at Yale, no longer climbing the steep stairs and eating the bitter bread of academic life. James Hyslop, now following the mystic grail. J. G. Hume, of Toronto University, who saved us from a narrow nationalism and with E. H. Griffin, dean and scholar of the Johns Hopkins University, saved us from a narrow empiricism. Joseph Jastrow, our first secretary, who this afternoon is here to tell us of the work in which he himself has been such a great part. George H. Fullerton, my first professional colleague and comrade, acute thinker, one

of our early presidents, now far away. Lightner Witmer, my first student and my successor at Pennsylvania, where he leads in an important field of research. G. T. W. Patrick, of Iowa, and H. K. Wolfe, of Nebraska, influential as teachers and in their work in psychology and philosophy. Last and most honored of the living, G. Stanley Hall and George T. Ladd, our first two presidents, then seeming to be veteran leaders, but now having become my contemporaries, men to whom we owe so much in so many ways, founders not only of our association, but also of psychology.

To the twenty-six original members, five were added by election at the preliminary meeting. Death has taken from us T. Wesley Mills, of McGill, early worker in animal psychology, and H. T. Ormond, of Princeton, distinguished philosopher. Edward Pace seems to be sheltered from us by the wings of the church in the educational work in which he is engaged. Then there were two men elected not only into the association, but selected from the whole world, because they were those whom we wanted and needed, E. B. Titchener and Hugo Münsterberg.

I once wrote: "Harvard with James Münsterberg, Royce . . . surpasses every other university in the world in its opportunity for psychological study and research." Now they all await us "where beyond these voices there is peace"—Hugo Münsterberg, always my friend since our student days in Leipzig, who with the hand of genius threw prodigally broadcast the diverse endowments of his great nation and his great race; William James, "the sweetest, wisest soul of all my days and lands"; there is none like him, none, nor will be; and Josiah Royce, his friend and ours, the well-beloved disciple, who leaves the world darker, now since his light is quenched.

Should the roll be called of the present membership of the association, there would be three hundred and seven to respond, and there are besides ten former members and others who stand among the hundred leading psychologists according to the list which I have compiled by objective methods.[2] The number of those professionally engaged in psychological work has increased nearly tenfold in twenty-five years. The original members represented 14 colleges and universities. There are now 122 institutions in which our members teach. Then the *American Journal of Psychology*, recently established, stood almost alone; now the published directory of American psychological periodicals contains eighteen titles. This is a growth of our work that has scarcely been paralleled in the history of science.

While it is not feasible to name all the individuals now composing the association, it may be well to give some data in regard to their distribution. The numbers in our chief institutions—including my own—are larger than I had supposed before counting them up. They are: Columbia 23,[3] Chicago 11, Cornell and Harvard 10, Clark, Johns Hopkins and Ohio State 8, Illinois and Michigan 7, Iowa, Pennsylvania, Princeton, Wisconsin and Yale 6, Minnesota and Pittsburgh 5, Bryn Mawr, California, New York University, Texas and Western Reserve 4, Brown, Northwestern, Vassar and Wellesley 3. There are 96 institutions with one or two psychologists—32 universities, 42 colleges and 22 normal

2 They are: Frank Angell, J. Mark Baldwin, J. E. Creighton, Edwin B. Holt, J. H. Hyslop, Herbert Nichols, E. A. Pace, George Santayana, E. W. Scripture and C. A. Strong. Several of them are primarily interested in philosophy; three reside in France. More than 90 per cent. of our psychologists are thus members of the association.

3 On Christmas day died Naomi Norsworthy, associate professor of educational psychology in the Teachers College, skilled in research, a truly great teacher, a noble woman.

schools in which psychology is being taught by our members.

272 of our 307 members are now or were recently engaged in teaching (including educational administration). This is a larger percentage than in any other science except mathematics. Most of the remaining 35 have also taught. Of these there are eleven who are engaged in work unrelated to psychology, supposing this to be the case for married women, for there are nine women among the eleven. We have one museum curator, two clergymen, and two practising physicians. Then there are sixteen connected with boards of education, hospitals, laboratories of reformatory and charitable institutions and the like. It is not impossible that this group, now so small, may at our fiftieth anniversary surpass in numbers those engaged in teaching.

258, or 84 per cent., of our members are recorded as holding the degree of doctor of philosophy. Psychology is the most academic of all subjects, a larger percentage of psychologists having taken the advanced university degree than is the case in any other science. Thus in a study made several years ago I found that about 60 per cent. of zoologists and of mathematicians, who in this respect come next to psychologists, have taken the degree and the percentage falls to about 10 for anatomists and pathologists. The American universities which have conferred more than two of these degrees are: Columbia 46, Harvard and Chicago 31, Clark 25, Cornell 24, Johns Hopkins and Yale 15, Pennsylvania 11, Iowa 6 and Michigan 4. The foreign universities are: Leipzig 15, Würzburg, Berlin and Freiburg 3. These fourteen institutions have conferred all but 27 of the 258 degrees. But while psychologists have taken their advanced degrees from a small number of institutions their college origin is very wide. They come largely and increasingly from the institutions of the central and western states, but the data at hand do not permit of a numerical statement. In my previous study I found that psychologists were as likely to come from small colleges as from large institutions having strong departments, and that those from the smaller institutions were equally likely to be distinguished.

At our second meeting, held in New York in 1893, Professor Mary W. Calkins and Mrs. C. Ladd Franklin were elected to membership. We were thus tolerably prompt to recognize equality of opportunity for the sexes, and this record we have maintained, for we now have 39 women among our members. Thirteen per cent. of women may be an unlucky number—it does not represent the ratio of the sexes—but it is larger than in any other science. I have recently counted up the number of women in my Biographical Directory, and find that among the 224 psychologists, 9.8 per cent. are women. Zoology stands next with 7.5, and the percentage falls to 2.1 for chemistry and 1.3 for physics and geology. Of our 39 women members 36 have the degree of doctor of philosophy, 11 from Chicago, 5 from Cornell and 3 from Columbia. If we should use the illegitimate method of projecting the curves of attendance in our courses in psychology at Columbia, we could set the date when it will be no longer a coeducational institution.

I think it is safe to state that we are now doing more work in psychology than any other nation. I once counted up the entries in the Index covering the first 25 volumes of the *Zeitschrift für Psychologie*—from 1890 to 1902—containing references to the articles published in the journal or reviewed by it, the more important contributions to psychology from the German point of view. It was disclosed that during this period America led all nations in experi-

mental work, exceeding Great Britain in a ratio of 10 to 1, that in theoretical contributions we were about equal to Great Britain, but were doubled by France and tripled by Germany. In contributions of a physiological and pathological character we fell far below these nations and below Italy, Germany surpassing us in a ratio of nearly 10 to 1. I have found no convenient way of making a similar comparison for the more recent period, and all contemporary international comparisons are now impossible. "Who's Who in Science," published in England in 1913, attributed 84 of the world's leading psychologists to the United States, as compared with 31 to Germany, 27 to England and 13 to France. This is a predominance which according to the book the United States holds in no other science.

We may wonder whether the importance of the work accomplished in this country for psychology has increased in the same ratio as the number of those engaged in it. It would not be fair to expect to see ten Jameses in this room, just as it would be unreasonable to look for five Darwins in England, because its biologists may have increased five-fold in a generation; or twenty Newtons, because the physicists may have increased twenty-fold since his time. But do we have a hundred members doing work as valuable as that of the more productive ten of those whose names I have recalled among our first members? Probably we have; in so far as it may seem otherwise, this may be because there are in the earlier days of a science more opportunities for original departures, but more especially to the fact that the relation of eminence to numbers follows a psychophysic law of its own. The number in a group who become eminent tends to be a constant, dependent on the limitations of the attention and the interest of the members. Thus a savage tribe may have as many distinguished chiefs and warriors as a nation of a hundred million. We may be unable to see the trees for the forest.

It would be impossible in the time allotted to me to give a history of the development of psychology during the past twenty-five years or an account of American contributions. It seems to me that the lines of development, especially in this country, have been in the directions which from the beginning I have followed, though my advocacy and example have doubtless been epiphenomenal. These are to ally psychology and its methods with the natural and exact sciences rather than with philosophy; to replace introspection and verbal descriptions by experiments and measurements; to investigate behavior and conduct rather than mind and consciousness; to study individual and group differences; to make practical applications and develop a profession of applied psychology.

Mr. Dean R. Brimhall has counted up for me—so my own prejudices are eliminated—the papers presented at the twenty-five meetings of the association. The reports have been printed in *The Psychological Review* and *Bulletin*, except those of the first two annual meetings, which were printed in a brochure which was edited by me as secretary. On the chart is shown for five-year periods the percentages of papers in accordance with their character. Applied psychology and individual psychology are cross classes, the same papers being listed for a second time and also largely in both classes. Only a rough subdivision is feasible, but it serves to show the distribution of our interests and the changes that have taken place in the course of twenty-five years.

In order to obtain information concerning present work, I have used the method of the questionnaire—a psychological tool which we owe in large measure to Stanley

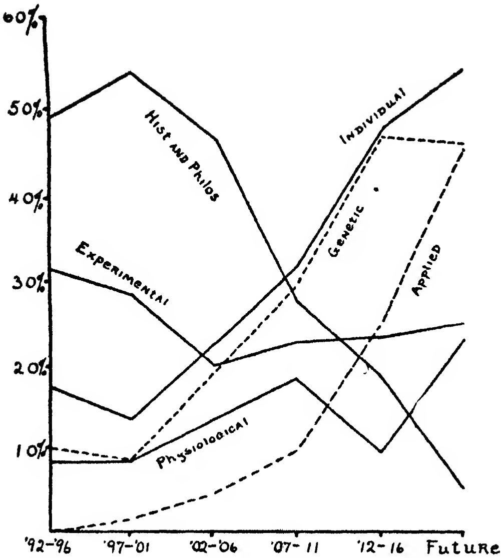

CHART SHOWING THE DISTRIBUTION OF WORK OF AMERICAN PSYCHOLOGISTS

Hall, though some of us may at times regard it as an invention of the devil. Members of the association were asked to fill in a blank stating the psychological researches in which they are engaged or plan to take up soon and the amount of time they are able to spend on research. Of the 220 who replied, 68 either reported that they are not at present doing research work in psychology or signed the blank without making a report. Of the 87 members who have not replied there are only a few who are doing work of consequence. More than 90 per cent. of those working in psychology are members of the association, and the replies consequently represent fairly well the work now in progress.

The last ordinate of the curve is for this work. When more than one research was reported the subjects were distributed fractionally so that the 152 replies give an equal number of researches and represent the work of so many individuals. The most impressive exhibition is the small amount of attention given to historical, critical, philosophical and analytical subjects, and that half of all the work is devoted to genetic and educational psychology. The suicide of philosophical papers is in part accounted for by the birth of our child—The American Philosophical Association—and does not necessarily represent a decreased interest in philosophy in America. It does, however, mean the establishment of psychology as a science completely independent of philosophy.

We are each year carrying forward more and more research work and, I trust, are continually improving its quality. We are doing a larger quantity of work than any other nation and work of equal value. But our accomplishment falls far below what it might be and should be. Psychology does not attract a sufficient number of able men and adequate opportunity is not given to them. I suppose the median salary paid psychologists who teach is less than that of employees in the railway unions, nor do we have the eight-hour day. The Ph.D. with all its outfit is a trap baited for mediocrity rather than for intelligence, and the victim gets caught at the advanced average age of 28 years. Then he must teach or starve or both. He has done research work of a kind, but whether it has been the mere routine attempt to solve a set problem or promises original performance, he is stewed in the same juice. He is not given a position unless he has done the modest amount of work required for the doctorate, but the position is usually such that further research work is prohibited. If he shows exceptional ability he may receive a minor university appointment with extension and summer courses, and if he continues to show ability he may become a dean or a president or some such thing. Scientific research and productive scholarship are regarded as desirable accomplishments, and men are sometimes called from one institution to

another because of their advertising value, or promoted in their institutions to ward off such calls; but usually the only considerable and tangible reward open to an investigator is transfer to an executive position which makes further investigation impossible.

The situation is illumined by answers to my questions. Of those who report that they are doing research work, 109 give the percentage of their working time that they are able to devote to it. Sixteen are able to give more than half their time to research, 50 from quarter to half, 43 less than quarter, 106 of our members are doing no psychological research. A man must be regarded as an amateur in work to which he does not devote more than half his time. If we add to the sixteen professionally engaged in psychological research, an equal contribution from those who did not reply to the questionnaire or to this particular question, the number would be about doubled, but they are not in fact nearly so many, and some of those who reported are doing work primarily physiological or psychiatric in nature. We have all told fewer than 25 men who are able to devote more than half their time to psychological research, men who may be regarded as professionally engaged in investigation.

It is further a misfortune or crime of the first magnitude that there is but little correlation between the performance of the men and the time they are now able to devote to research. Of the four men who state that they are able to devote all their time to such work, one is a young man temporarily out of a job, one holds a research fellowship, one a subordinate position in an industrial laboratory, one has an institutional position. If we divide the members into three classes of merit, the first 30, the second 70 and the balance of 207, in accordance with the selection by ten leading psychologists which I have previously described, and which has recently been made for the third time, we get this arrangement for those who answered the question:

Time Devoted to Research	Class I	Class II	Class III	Total
More than 50%......	4	4	8	16
25% to 50%...	9	15	26	50
Less than 25%........	10	25	114	149
Total..................	23	44	148	215

The largest group, one ominously large, is not unnaturally those who do little or no research work and who are undistinguished. But apart from this group it appears that those with greater ability for research are not able to devote considerably more time to it than others.

The conditions adverse to research are not peculiar to psychology nor even to science. They hold in all cases where services are for the benefit of society as a whole rather than for individuals or groups. Men can not undertake research as a profession and be paid in accordance with the value of the work they accomplish. Aristocratic institutions have devised schemes for the reward of research, but these can not be transported overseas to a democracy. We do not want a leisure class in order to secure certain desirable by-products. A title, presentation at court, or an invitation to dine with a lord, can scarcely have an equivalent here. Membership in a national academy of sciences, a gold medal or an honorary university degree is a feeble stimulus, belonging to other days and other ways than ours. The payment of scientific men, as of soldiers, in the fiat money of honor and glory, like the inexpensive offering of happiness in heaven to compensate for meekness and misery on earth, is not a method of modern democracy.

There are four ways by which research work in psychology and other sciences can

be undertaken as a profession: (1) At our universities and colleges, in so far as these recognize that research work is part of the service for which instructors and professors are paid; (2) under the federal government, the states and the municipalities, when these regard the promotion and payment of research as a function of the state; (3) in endowed research institutions or in charitable and public institutions in which research is considered part of their objects, and (4) in cases where work can be conducted on an economic basis. For psychology we have no endowed research laboratory, the state does but little, our discoveries are not patentable and our expert knowledge is but rarely saleable. Nearly all of us are employed by universities and colleges, and we are in the main dependent on them for the opportunity to do the work that is done. Their attitude is on the whole favorable and is improving.

As secretary of a committee of the American Association for the Advancement of Science, I have addressed inquiries to all our institutions of higher education, asking the extent to which research work and productive scholarship are considered in making appointments and promotions and are regarded as part of the work for which instructors and professors are paid. Nearly all the replies emphasize the weight laid on research.

The president of Harvard University writes:

> In the making of appointments and promotions at Harvard University, greater weight, on the average, is given to scientific research and productive scholarship than to any other single consideration. Research is a part of the work expected from instructors and professors.

The president of Columbia University:

> In making recommendations for appointments and promotions in the faculties of Columbia University, the several departments concerned are expected to give predominant weight, and as matter of fact do give predominant weight, to capacity for scientific research and to evidence of productive scholarship.

The president of the University of Wisconsin:

> Scholarly work or research is a part of the work expected of instructors and professors. When presenting statements to the legislature I have estimated that upon the average from one third to one fourth of the cost should be charged to investigation.

The president of the University of Illinois:

> The work of research is fundamentally a part of the duty of the university, and this is especially true of state universities. Necessary equipment and necessary time should be allowed for every member of the staff to be actively engaged in some piece of research work all the time.

Letters such as these are full of encouragement for the future; but we must remember that it is not on university presidents and trustees but on us ourselves that the future depends.

To individual philanthropy we owe the endowment of research and of institutions expressly devoted to research. We have long had endowed astronomical observatories, and it is due to this circumstance that America has done relatively better in astronomy than in any other science. Museums, botanical gardens and similar institutions have more and more seriously added scientific investigation to their other functions. But it is only within recent years that the Carnegie Institution of Washington and the Rockefeller Institute for Medical Research have been established, and we see in them for the first time in history research in pure science conducted as a profession. There is urgent need of an adequately endowed Institute for Psychological Research; but we can scarcely expect one of our members to supply the needed ten million dollars.

Our federal government makes larger

appropriations for scientific research than any other nation, and the money has on the whole been used to advantage. The fact that the work there is mainly economic is not, in my opinion, altogether a drawback. The difficulty has been that better provision is made for routine work than for exceptional performance. The present emergency has led to further large appropriations by congress for scientific research, and we may hope that the truth expressed in the President's words "Preparation for peace is the best preparation for war" will lead to still greater efforts to promote science for the national welfare. The government has done practically nothing for psychology, and the Bureau of Education is inadequately supported. The Smith-Hughes bill, however, provides a considerable sum for educational research, a large part of which will be psychological in character. Public education is supported with increasing appreciation throughout the country and our educational systems are gradually learning the importance of psychological experts. State supported institutions for the defective and criminal classes are also beginning to make such appointments.

The patent laws were enacted before psychology had been invented; there is at present no way by which ideas can be controlled for the profit of the man who gives them to the world, even to the smallest percentage of the value of his gift. How this may be corrected may itself become an object of psychological research. If some means could be devised by which the state could pay for the services of individuals in accordance with their value to the state, the progress of science and of civilization would be greatly accelerated. In the meanwhile the psychologist may increase an inadequate salary by the writing of textbooks and by outside teaching and lecturing, but he usually does so at the sacrifice of research. There may soon be psychological experts whose advice will be paid for at the same rate as is now paid for the advice of physicians, engineers and lawyers. It is a curious circumstance that while the plan is being introduced of full-time professors of medicine with relatively adequate salaries, the professors in the graduate faculties must increasingly support their families by outside work. The cost per student or per professor of the magnificent buildings and grounds of the university where we are now meeting is perhaps four times what it once was or need now be for purposes of teaching and research, whereas the effective value of the salary of the professor at Columbia is now about one fourth what it was thirty years ago.

It is our business as individuals and especially as united in this American Psychological Association to use all possible efforts at all times, in all places and in all ways to improve the conditions under which research work is done. Science has doubled the length of human life and quadrupled the productivity of labor. A single advance in applied science, such as the Bessemer steel process or the electromagnet, discovered by Faraday in the only research laboratory then existing, may add annually some two billion dollars to the wealth of the world. The psychological and social sciences have already done their share in freeing us from superstition and unreason, in leading us to tell the truth as we see it and in some measure to see the truth as it is. They have repaid many fold their cost in economic applications. An improvement of ten per cent. in the educational work of this country saves us a hundred million dollars a year. But it is to the future that we look to obtain a control over human conduct corresponding to that of physical science over the material world, and more vital. We must eliminate the in-

calculable waste of preventable idleness, misfit employment, disease, vice, crime and war; we must divide wealth more fairly and use it more wisely, we must alter fundamentally all our institutions, the family, the church, the school, the courts, government and the rest; each must be enabled to give what he best can and to receive what he most needs. And, as I said twenty-two years ago—before that "infant industry" eugenics had begun its career—in my address as president before this association:

> We not only hold the clay in our hands to mould to honor or dishonor, but we also have the ultimate decision as to what material we shall use. The physicist can turn his pig-iron into steel, and so can we ours; but he can not alter the quantities of gold and iron in his world, whereas we can in ours. Our responsibility is, indeed, very great.

J. McKeen Cattell

AN INSTITUTE FOR THE HISTORY OF SCIENCE AND CIVILIZATION

To those interested in placing before American students advantages not only greater than are now offered in this country, but greater than those offered abroad, the following statement may suggest an opportunity.

The history of science deals with so large a part of the intellectual development of the race, that it should attract the interest of every thinking person. Such an interest is already manifest among an ever-increasing number of scientists and technicians. Furthermore, a very general interest is also becoming apparent, for example, in the history of the numerous means of locomotion from the first beasts of burden to the airplane of to-day; in the history of computation from the ingenious but rude abacus to the refined calculating machine; in the history of such methods of communication as telegraphy and telephony and in the history of medical and surgical practise.

If we consider it from a higher point of view, the importance of the history of science becomes even greater. We then realize that science is the strongest force that makes for the unity of our civilization, that it is also essentially a cumulative process, and hence that no history of civilization can be tolerably true and complete in which the development of science is not given a considerable place. Indeed, *the evolution of science must be the leading thread of all general history.*

The more scientific research becomes specialized, the more do coordinating studies of some kind become necessary to keep scientists interested in one another's work. Specialism, indispensable as it is, should not be allowed to obscure the broader vision, and there is no better way to prepare these coordinating, encyclopedic studies than to unfold as clearly as possible the evolution and interrelations of all sciences. These have not grown independently, but together, the progress of each making further progress possible for all the others. *The history of science is the essential basis of any philosophy of science, indeed of any philosophy which is not mere metaphysics or literature.*

Science is ever growing and is becoming daily a more important factor in the field of education. Science it is which makes it possible for men to tame the forces of nature to their purpose; which is the foundation of all material power; which is the backbone of our civilization. Knowledge is power, but this power may become a danger if its spirit be false and if it be bent solely upon material achievements. It is only when science is explained and tempered by history that it acquires its whole educational value, and that the main objections to scientific education cease to be valid. *The more science enters into our lives, the more it must be "humanized," and there is no better way to humanize it than to study its history.* Such studies, reconciling the purely scientific, the historic, and the philosophic points of view, would be the source of the soundest and highest idealism.

The field of the history of science as we have defined it is, of course, too broad to be adequately covered by separate departments in any of our universities. This can only be accomplished by an institution devoted strictly to this purpose and adequately equipped for

the great work that needs to be done. Such an institution should open its doors freely to the few who are sufficiently advanced to profit by its help, but it should not be hampered by any question of degrees or credits, remaining free to do for the advanced student what it feels will be of service in establishing the highest standards of research and scholarship.

An institute devoted to this work, by whatever name designated, would need to be sufficiently endowed to be independent of fees or of large financial returns from its publications. It might be established independently, with a building of its own in any city with abundant library and museum facilities, or it might be endowed to work as part of some institution already organized, such as a large university or a museum of science.

Such an institute should have among its activities the following:

1. To offer to qualified students the best equipment for work and the advice, assistance and encouragement of a small corps of experts in the history of science.

2. To afford to universities, libraries and scholars the opportunity to acquire at cost photographs of important manuscripts, documents and objects, thus making it possible to study leisurely at home many original sources that at present can only be examined abroad and at a considerable expenditure of time and money. To this end there should be secured the best available technicians, with the best types of apparatus, working both in foreign libraries and in the laboratory of the institute.

3. To offer to scientists interested in history, to historians interested in science, and to cultivated philosophers a meeting place worthy of their respect; a clearing-house where all matters of common interest to them would be centralized, examined and eventually made known to the world.

4. To begin collections of prints, instruments and all other early material bearing on the history of pure and applied science. This activity could in course of time expand into a department of enormous importance, as is clear to any one who has visited the Conservatoire des Arts et Métiers in Paris, the Science Museum in Kensington, or the Deutsches Museum in Munich, foundations with which we have nothing to compare in this country.

5. To publish two journals, one of a popular nature and the other of the highest scientific character. The former should set forth in an interesting manner the latest discoveries in the history of familiar science, appealing to the eye through the best style of illustration and to the intellect through popular but accurate and scholarly statements. It should also give much attention to the history of civilization in all its highest features, and should thus do for history, though in a more scholarly way, what has already been so successfully done for geography. The scientific journal might be a series of editions of important scientific manuscripts or a journal of the type of *Isis* which should record the world's work on the subject. In such a journal great attention should be given to bibliography, not merely external but also internal and critical. For this purpose the institute should carry on, in its own field, the coordination of the most thorough bibliographical work, mobilizing the best critical talent available.

Such an institute would not rival any department in our universities. It can and should set a higher standard of scholarship by reason of its independence, and it should be looked upon as a valuable aid by every university in this country and abroad, and as a source of supply of material which no university or library can furnish.

The institute would need to begin its work with a small staff of experts; with a small number of well-trained technicians, including photographers and process workers; with bibliographical and clerical assistants; with a well-chosen library; and with the best facilities for scientific bibliographical work. It would, of course, be necessary to do part of the work abroad, since it would be too expensive to assemble in any one place all the scholars whose cooperation would be essential to the best success. This is especially the case with respect to the Oriental civilizations, in connection with which a great amount of pioneer work remains to be done.

The international character of the institute should also be fully recognized. Although located in America, its field of influence would extend equally to all other countries and it would develop a power for internationalism the value of which could hardly be exaggerated. It is a serious misfortune that, whereas there are thousands of organizations devoted to local history, or to such auxiliary branches as heraldry, genealogy and numismatics, there is nowhere a single one that is dedicated to the historical study of that which is *the greatest common good to all mankind,* the excellent institute in Leipzig being devoted exclusively to the history of medicine. It would place the New World in another light if there could be founded here, especially at this time, an institute which might in the near future become the cradle of new intellectual movement, of a new humanism.

There is already a gratifying interest in the project. Two or three of the finest libraries on the history of science and of its special branches are likely to be given to the institute if it is founded on the lines above set forth.

The following scholars have written to express their interest and sympathy and most of them have promised some kind of collaboration:

Joseph Sweetman Ames, Wilder Dwight Bancroft, Fr. Barry, Alexander Graham Bell, George David Birkhoff, Franz Boas, Marston Taylor Bogert, James Henry Breasted, George Lincoln Burr, Florian Cajori, William Wallace Campbell, Paul Carus, William Ernest Castle, James McKeen Cattell, William Bullock Clark, Frank Wigglesworth Clarke, Thomas Chrowdel Chamberlin, Russell Henry Chittenden, William Thomas Councilman, Henry Crew, Harvey Cushing, Charles Benedict Davenport, William Morris Davis, Arthur Louis Day, John Dewey, Leonard Eugene Dickson, Henry Herbert Donaldson, Jesse Walter Fewkes, Edwin Brant Frost, Fielding Hudson Garrison, George Ellery Hale, Granville Stanley Hall, Charles Homer Haskins, Lawrence T. Henderson, T. William Francis Hillebrand, William Ernest Hocking, R. F. Alfred Hoernlé, William Henry Howell, Edward Vermilye Huntington, Ellsworth Huntington, Morris Jastrow, Jr., David Starr Jordan, Louis Charles Karpinski, Arnold Carl Klebs, George Frederick Kunz, Berthold Laufer, William Libby, Frank Rattray Lillie, Ralph S. Lillie, William Albert Locy, Jacques Loeb, Graham Lusk, Percival Lowell [deceased], Franklin Paine Mall, George Herbert Mead, Samuel James Meltzer, Albert Abraham Michelson, Robert Andrews Millikan, Edward Caldwell Moore, Eliakim Hastings Moore, Ernest Carroll Moore, Arthur Amos Noyes, William Albert Noyes, William Fogg Osgood, George Howard Parker, Ralph Barton Perry, Edward Charles Pickering, Frederick Leslie Ransome, Theodore William Richards, David Riesman, James Harvey Robinson, Julius Sachs, William Thompson Sedgwick, Thomas Jefferson Jackson See, H. M. Sheffer, Paul Shorey, James Thomson Shotwell, David Eugene Smith, Edgar Fahs Smith, Edward Clark Streeter, Henry Osborn Taylor, Harry Walter Tyler, Victor Clarence Vaughan, Addison Emery Verrill, James Joseph Walsh, Arthur Gordon Webster, William Henry Welch, Edmund Beecher Wilson, James Haughton Woods.

In the matter of corespondence the undersigned will act for those interested in the movement until it is seen whether a more definite organization can be effected.

GEORGE SARTON

HARVARD UNIVERSITY,
CAMBRIDGE, MASS.

SCIENTIFIC EVENTS

TECHNICAL AND MEDICAL EDUCATION IN RUSSIA

THE London *Times* states that one of the most striking features of recent educational reform in Russia has been the unusual activity of Count Ignatiev, the ex-minister of education. There has been great need of people of higher education in Russia in two departments especially, the technical and the medical. In November last Count Ignatiev brought before the Duma a scheme for a new university statute introducing far-reaching reforms. Meantime many new technical and medical schools are already being provided for. Ten new technical institutes of various types are in process of organization, and in this connection Count Ignatiev approached the municipalities and Zemstva concerned, with a view to sharing the expense. These technical institutes are to be opened especially in the eastern part of the empire, in Saratov, Vyatka,

Turkestan and Blagoveshchensk. Of the several new universities which are under consideration, the first to be opened will be those of Perm and Rostov-on-the-Don. The scheme for the University of Irkutsk is to be brought before the Duma in the autumn of 1917, and another university in the Far East is planned for either Vladivostok or Habarovsk. All the towns which have been chosen as new centers of education have already voted sums of money, larger or smaller, according to their wealth. Some of the old universities—viz., those of Odessa and Tomsk, have been allowed to increase the number of their students. Perhaps the most marked reforms are in medical education, since Russia is faced with a greater need for medical staff than any other country. A new degree of candidate of medical science has been founded which, together with eight months' hospital training, entitles the holder to practise. The holder of this degree occupies an intermediate place between the fully qualified doctor and the so-called *feldscher* or nurse (male or female), who is allowed to practise in the absence of a doctor. There are also schools for four more classes of medical staff—disinfectors, maternity nurses, nurses for nervous cases and masseurs. These reforms are already being set in motion, and are to be carried out in the course of the next three years.

DINNER IN MANILA TO VISITING SCIENTIFIC MEN

A CORRESPONDENT writes from Manila:

On February 5, 1917, Dr. John A. Brashear, the noted American maker of photographic lenses and silver-on-mirrors, Dr. A. Swasey, president of the firm that made the mounting of the big Cordoba, Lick, Yerkes, Victoria telescopes, and Dr. John R. Freeman, the American hydraulic engineer, were entertained at a lunch given in their honor at the Manila Hotel by prominent scientists and engineers of Manila. To meet in the far-off Philippine Islands so many friends, enthusiastic for astronomy and for the application of modern machinery and methods to engineering problems was a delightful surprise to the distinguished visitors. José Algué, director of the Weather Bureau, welcomed the guests and acted as toastmaster. The speaker of the occasion was a personal friend of Dr. J. A. Brashear. Speaking of optical instruments made by Brashear, Rev. M. Selga, well known in America for his connection with the leading American observatories, made the following remark: "There is hardly any remarkable astronomical observatory in America that is not equipped either with a silver-on-mirror, or a lens, or a comet-seeker, or an alt-azimuth or a spectrograph constructed by Brashear. The 8″ doublet of Swarthmore College Observatory, the 15″ of the Dominion Observatory, Ottawa, Canada, the 18″ of the Flower Observatory, Philadelphia, Pa., the 20″ of Chabot Observatory, Oakland, California, the focus of the astronomical admiration of the visitors at the Panama-Pacific Exhibition, the unique 30″ photographic refractor of the Allegheny Observatory are but few among the many high-grade refractors turned out by Brashear. You are all acquainted with the spectrographic investigations of the late Dr. Young, at Princeton, of Dr. G. H. Hale at Kenwood, paving the way for the advance of solar physics and the establishment of the Mt. Wilson Solar Observatory, of Dr. F. Schlesinger at the Allegheny Observatory with the Mellon and Porter spectrograph, of Dr. Frost with the Bruce, of Plaskett at Ottawa, of Dr. Slipher at Flagstaff, and specially of Dr. W. W. Campbell who with the Mills spectrograph has surveyed the northern and southern skies for the spectral characteristics of the stars. Now, one of the vital parts, either the prisms or the lenses, of these unparalleled spectrographs are from Brashear." The guests gathered around the table at 12 o'clock and the steamer was to take the scientific party from Manila to Hongkong at 3 P.M. Few minutes were left to Dr. Brashear to talk on the stars, to Dr. Swasey to give his views about the Far East and to Dr. Freeman to report on the past, present and future condition of the Panama landslides. The speeches were short, but they were a source of pleasure and delight to more than a hundred guests and will be long remembered.

THE KANSAS CITY MEETING OF THE AMERICAN CHEMICAL SOCIETY

As has been already noted in SCIENCE the American Chemical Society will meet at Kansas City from April 10 to 14. The society and hotel headquarters will be at the Hotel Muehlebach. The final and complete program will be sent on or about April 3 to members requesting it. The program of general arrangements is as follows:

to each commissioner for distribution in his own country. A copy will be sent to any person sufficiently interested, who will apply to Dr. C. W. Stiles, secretary to International Commission on Zoological Nomenclature, U. S. National Museum, Washington, D. C.

Sir Alfred Keogh, director-general of the British army medical service, presiding at a lecture at the Royal Institute of Public Health on February 14, is reported in *Nature* to have stated that in France at that moment there were only five cases of enteric fever and eighteen cases of paratyphoid fever, with seventy or eighty doubtful cases. He attributed this result to inoculation, and the general good health of the army to good food, in addition to careful sanitation. The health of the army at all the fronts was said to be better than the ordinary health of the army in peace-time.

Dr. Leo J. Frachtenberg, of the Bureau of American Ethnology, returned to Washington, D. C., on February 4, after a stay of almost two and a half years in Oregon and Washington, where he investigated the ethnology, mythology and languages of the various Indian tribes scattered throughout these states. Dr. Frachtenberg's researches in this area have resulted in evidence that three of the most important linguistic stocks of the northwest, namely, the Salish, Wakashan and Chimakuan, have ultimately been derived from one common stock, which he proposes to call the Mosan group. This name has been suggested by the fact that the numeral 4 (*mós* or *bós*) occurs in each of these stocks in one form or another. While working on the social organization of the Chimakuan tribes Dr. Frachtenberg observed an entirely new feature in the social life of the American Indians. This feature consists of the existence of professional orders, whose members do and must follow one and the same profession. Thus there are special orders for fishermen, hunters, sealers, whalers, shamans, rainmakers, etc. During the last two weeks of his stay in the west Dr. Frachtenberg succeeded in raising a fund of $25,000 as a nucleus for the purposes of organizing a Museum of Natural History in the city of Portland, Oregon. On January 29 he succeeded in starting a similar movement in Spokane, Washington, and it is hoped that the city of Spokane will in the near future have a museum specially devoted to the American Indians of that region.

Preliminary estimates by John D. Northrop, of the United States Geological Survey, Department of the Interior, indicate that the quantity of crude petroleum produced and marketed in the old fields of the United States in 1916 was 292,300,000 barrels. This quantity is greater by 4 per cent. than the corresponding output in 1915, which reached the record-breaking total of 281,104,104 barrels. Mr. Northrop estimates that 38 per cent. of the 1916 total came from the Oklahoma-Kansas field, 30 per cent. from California, and the remaining 32 per cent. from the Appalachian, Lima-Indiana, Illinois, north Texas, north Louisiana, Gulf coast, and Rocky Mountain fields.

In 1916 Alaska mines made a mineral production valued at $50,900,000. These are the advance figures issued by the United States Geological Survey, Department of the Interior, and are based on estimates made by Alfred H. Brooks. The output of Alaska mines in 1915, which was greater than that of any previous year, had a value of $32,850,000, and the increase in 1916 was therefore over 54 per cent. It was the product of the copper mines that so greatly swelled the mineral production of the year. This amounted to 120,850,000 pounds, valued at $32,400,000. There was also, however, an increase in gold output, which in 1916 was $17,050,000 and in 1915 was $16,700,000. Of the gold produced in 1916, $10,640,000 is to be credited to the placer mines. Alaska also produced in 1916 silver, lead, tin, antimony, tungsten, petroleum, marble, gypsum and coal to the value of $1,300,000. During 32 years of mining Alaska has produced $351,000,000 in gold, silver, copper and other minerals. Of this amount $278,000,000 represents the value of the gold, and $68,000,000 that of the copper.

UNIVERSITY AND EDUCATIONAL NEWS

The legislature of Kansas appropriated $1,524,000 for the University of Kansas for the

next biennium, and $1,250,000 for the Kansas State Agricultural College. The three normal schools were given approximately $970,000, and the various other schools and sub-experiment stations $242,000. The total appropriation for all designated educational institutions was a little less than four million dollars for the two years beginning July 1, 1917.

THE will of the late William W. Lawrence, president of the National Lead Company, provides that on the death of Mrs. Lawrence a sum of over $200,000 will go to Princeton University.

A BILL has been enacted in New Jersey designating the scientific departments of Rutgers College as the State University of New Jersey.

ARRANGEMENTS have been completed between Northwestern University Medical School and the Chicago Fresh Air Hospital for a course of instruction in tuberculosis for the members of the senior class in the medical school. The class is divided into sections, each receiving clinical instruction for a period of four weeks.

To meet the increased cost of supplies and to permit an enlargement of educational facilities, tuition in the medical school of George Washington University has been increased from $150 to $175 a year, and in the dental school from $125 to $150, to take effect next fall.

DR. SCOTT NEARING has presented his resignation at Toledo University owing to criticisms made by citizens of the city of his anti-militaristic activities. It will be considered by a committee of the trustees.

IN accordance with the reorganization plan at the Creighton University College of Medicine, the bio-chemical and physiological laboratories have been merged into a single department under the direction of Professor S. Morgulis. Dr. William A. Perlzweig, of the Rockefeller Institute, has been appointed assistant professor of bio-chemistry in the department.

DR. ETHAN A. GRAY, medical superintendent of the Chicago Fresh Air Hospital, has been appointed assistant professor of medicine in Northwestern University.

DISCUSSION AND CORRESPONDENCE

A RELIEF MAP OF THE UNITED STATES

TO THE EDITOR OF SCIENCE: Mr. Kinkaid's proposition (SCIENCE, March 9), to construct a relief map of the United States "300 feet square or 600 feet square" would be, judging from my own experience, a pretty costly one. A relief map of the state of New York 35 feet long, east and west, and 26 feet broad, north and south, now in our museum, cost $17,000 to make. Estimating broadly the dimensions, area and cost of a map of the entire United States on the same scale, the map would be 237.5 feet long, and at the same proportion of cost the expense of making it would be $1,045,500. This is on the scale of one mile to the inch. If the scale were one half mile to the inch, the cost would be, in the same proportion, $4,182,000.

And where in Washington or elsewhere would Mr. Kinkaid put such a map of the United States, 600, or even 300 feet long? There is no building large enough to hold it. Buildings 600 feet long and 300 feet wide are not bagatelles. Perhaps one might be built for a million dollars, but it is doubtful.

Surely for this proposition, as Mr. Kinkaid suggests, "the main problem is to find the philanthropist." But before going out to hunt him, let us remember that only 40.2 per cent. of the United States has been covered by topographic surveys in such detail as to give an adequate basis for such a relief map as he has dreamed of.

JOHN M. CLARKE

STATE MUSEUM,
ALBANY, N. Y.

AN ANCIENT REFERENCE TO THE EMERALD

OUR college librarian, Professor Chipman, while arranging a course on "Books and Libraries" happened to call my attention to a translation of the oldest known manuscript which could justly be called a book, an Egyptian parchment entitled "The Instruction of Ptah-hotep."[1] In glancing it through I came across this interesting sentence:

[1] Translated by B. G. Gunn. E. P. Dutton, 1910.

Fair speech is more rare than the emerald that is found by slave-maidens on the pebbles.

Since the actual parchment is said to date from 2500 B.C., and since Ptah-hotep lived about 3500 B.C., this gives us a written mention of the emerald and its occurrence as a placer mineral on a document 4,500 years old, and shows that it was prized as a gem about 5,500 years ago, perhaps 2,500 years before the "Iliad" and "Odyssey" had come into existence, and over 2,300 years before the traditional date of the siege of Troy.

Whether the word here translated emerald is strictly the emerald as we define it I do not know. At any rate such a translation harmonizes with the usual implication that Egypt is the place of earliest recognition of the stone. The Encyclopedia Britannica, for instance, says:

> Ancients appear to have obtained the emerald from upper Egypt, where it is said to have been worked as early as 1650 B.C.

The document under discussion shows that it was searched for and prized almost 2,000 years before this.

The same publication that contains the "Instruction of Ptah-hotep" contains a short "Instruction of Amenembê'et" who ruled in Egypt about 2778–2748 B.C. He remarks:

> I have made me an house adorned with gold, its ceilings with lapis lazuli. . . .

This document in the part quoted is said not to be so reliable as the preceding one.

Since a geologist would only by accident have this book called to his attention, it seems worth while to quote such ancient—so far as I know the most ancient—references to these minerals. HOMER P. LITTLE

COLBY COLLEGE,
WATERVILLE, MAINE

METHYL AND ETHYL ALCOHOL

TO THE EDITOR OF SCIENCE: When the Mapp prohibition law, which went into effect in Virginia last November, was before the state legislature we communicated with our representative, asking that the interests of the colleges be safeguarded in respect to the use of alcohol for scientific purposes, but the law as enacted ignores biological laboratories entirely. We are therefore compelled to seek a substitute for ethyl alcohol, at least until the law can be amended. Hence the following queries:

1. Can methyl alcohol be substituted generally in processes of dehydration without modifying the methods otherwise or without prejudice to the staining or keeping qualities of the preparations?
2. Can methyl alcohol be generally substituted in the formulas for stains, etc.?
3. Are there any special cases in which this substitution may not be made?
4. What kind of methyl alcohol should be used?

The manuals on histological technique give little information on this question, but it may be that someone in "bone dry" territory has found a substitute for ethyl alcohol. If so, there are a number of readers of SCIENCE who would be grateful to hear of it.

J. I. HAMAKER

RANDOLPH-MACON WOMANS' COLLEGE,
LYNCHBURG, VA.

SCIENTIFIC BOOKS

Institut de France. Académie des Sciences, Annuaire pour 1917, Paris, Gauthier-Villars et Cie. sm. 8vo ($17 \times 11 \times 1.3$ centimeters). 315 pp.

The Yearbook of the Académie des Sciences bears but slight trace of the terrible experience through which France is now passing, an experience all well-wishers of our traditional friend trust will have a speedy ending. It is thus a grateful sign that science may pursue her way unperturbed by the conflicts of the hour, and may have nothing to unlearn or to forget when the period of destruction and suffering brought about by an outbreak of man's basest passions shall have at last been brought to a close.

The most attractive part of the *Annual* for one interested in the history of science is the complete biographical index of all the members and correspondants from 1795 to 1917 (pp. 111–288). In this register of 1,188 names appear all the leaders in French science for the

period mentioned, and a large number of those in foreign lands. The name of one of the greatest men in the world's political history is also to be found here, that of Napoleon Bonaparte, who was elected resident member of the section of mechanical arts in the First Class of the reorganized Institut National, on December 25, 1797 (5th Nivôse An VI.); two years later he became president of this class. It should be borne in mind that this was at the very outset of his career, in the year of the first Italian campaign. In our own day another soldier of France, General Gallieni (died May 27, 1916), who aided greatly in the defense of Paris during the critical first weeks of September, 1914, was a correspondent of the section of geography and navigation.

One of the most interesting figures among the academicians of the past century was the centenarian chemist, Michel Eugène Chevreul, born September 1, 1786, elected member of the section of chemistry, August 7, 1826, president of the Académie in 1839 and 1867 and who died in Paris April 9, 1889, aged one hundred and two years, seven months and eight days, his lifetime extending from the reign of Louis XVI. down to the centenary of the French Republic.

The oldest member living at the time the *Annuaire* went to press was the rural economist Jean Jacques Schlœsing, born in Marseilles, July 9, 1824, and therefore now in his ninety-third year. The Académie counts two other nonogenarians, the rural economist Auguste Chauveau, born November 21, 1827, and the mathematician Charles Wolf, born November 27, 1827; there are a half-dozen octogenarians.

Of the correspondents chosen from 1795 to 1917, eighteen were born in the United States; three of them, the astronomers Edward Charles Pickering and George Ellery Hale, and William Morris Davis, correspondent of the section of Geography and Navigation, are still living.

The organization of the Académie at the present time permits the election of 66 full members (Membres Titulaires), six for each of the eleven sections. There are besides two perpetual secretaries, one for the division of mathematical sciences, the other for that of physical sciences; ten Académiciens Libres, six Membres Non Résident, and twelve Associés Étrangers; to these may be added 116 correspondents. The full complement in the different classes, and the number actually registered at present, are given as follows:

	Allowed by Statutes	Registered in Yearbook
Membres Titulaires	66	57
Secrétaires Perpétuels	2	2
Académiciens Libres	10	9
Membres Non Résidents	6	4
Associés Étrangers	12	6

The members of the Académie are distributed in eleven sections, the division *sciences mathématiques* comprising five sections, geometry, mechanics, astronomy, geography and navigation and general physics, the *sciences physiques* embracing the following six sections: chemistry, mineralogy, botany, rural economy, anatomy and zoology, and medicine and surgery. Each of these eleven sections is restricted to a membership of six, so that a scientific specialist, however great his renown, must await not merely a vacancy in the Académie, but one in the particular section to which he belongs. By this means an equal balance is always maintained and there can be no undue preponderance of any single scientific branch, or of any group of such branches.

G. F. K.

THE PINK BOLL WORM

The newspapers of the country in the last few months have called attention to the fact that a most serious pest of the cotton plant known as the pink boll worm (*Gelechia gossypiella* Saund.) has been established in northern Mexico through the shipment of several tons of Egyptian cotton seed to that country in 1910. The insect is one which is especially likely to be transported over long distances. It can live for more than a year in stored cotton seed, thus furnishing an opportunity for shipment to the remotest parts of the globe. As a matter of fact it was carried from

India, which was probably its original home, to Egypt about a dozen years ago in cotton seed.

The Department of Agriculture has undertaken strenuous measures to prevent the introduction of the pink boll worm from Mexico. The introduction of cotton seed and of baled cotton which often carries scattered seeds has been prohibited, and Congress has made a special appropriation under which very thorough work in enforcing quarantine measures can be done on the Texas border.

It is interesting to note the recent experience of Brazil with the pink boll worm. In 1913 the Brazilian government paid considerable attention to the encouragement of the culture of Egyptian cotton in that country. An agent was sent to Egypt and large quantities of seed were shipped to Brazil. This seed was distributed throughout the republic by a branch of the Ministry of Agriculture. This branch has inspectors in every state capital. Each one of these received quantities of the seed and distributed it free to all applicants. A more thorough method of dissemination of an insect in a new country could hardly be devised. Early in 1914 a careful survey of the cotton belt of Brazil was made by an American who was engaged in the encouragement of cotton culture in the republic. He found no indications of the cotton boll weevil for which he was looking especially or of any other insect pest attacking the seed or bolls. Late in 1916 he made another trip over the same territory and found that the pink boll worm was generally and thoroughly established. In fact the pest was so numerous that the yields of certain fields were reduced by half. Naturally the situation attracted great attention and many suggestions were made about relief measures. Some of the legislators suggested the passage of a law compelling the burning of all cotton fields in Brazil. Of course it is too late to stamp out the insect by any such means, but the whole episode emphasizes enormously the importance of quarantine measures to prevent the introduction of pests which in all probability can never be exterminated when they have once become established.

W. D. Hunter

Bureau of Entomology

SPECIAL ARTICLES

THE EFFECT OF RETARDATION OF GROWTH UPON THE BREEDING PERIOD AND DURATION OF LIFE OF RATS[1]

During the course of our experiments on nutrition we have had a number of rats which were stunted for various periods of time. With respect to these animals the question has frequently been raised as to whether this retardation of growth tended to prolong their life beyond the average span; that is, whether physiological age is a function of time alone or also of growth. The inquiry then becomes pertinent as to what may be considered the average length of life of a rat.

Donaldson[2] states that "a rat three years old may be regarded as corresponding to a man ninety years old." Slonaker[3] has reported that one of his rats reached an age of 45 months; and recently one of our rats, although fed on a uniform experimental diet since it was 6 weeks old, reached the age of 40 months —the longest life yet recorded for our colony. In an attempt to find out how long our rats might be expected to live, we have at various times set aside a number of stock rats to be kept under our ordinary laboratory conditions during their entire lifetime. Out of 91 such animals, 17 (19 per cent.) died under one year of age; 48 (53 per cent.) died between one and two years of age; and 26 (29 per cent.) lived more than two years, the oldest one reaching an age of nearly 34 months. From these figures it is evident that less than a third of the rats in our colony may be expected to live to be more than two years old.

Considering the wide variations in the ages of these rats it was thought that possibly a more definite, although an indirect answer to the question of the effect of stunting upon the length of life might be obtained by determining the age to which stunted females remain

[1] The expenses of this investigation were shared by the Connecticut Agricultural Experiment Station and the Carnegie Institution of Washington, D. C.

[2] Donaldson, H. H., "The Rat," Memoirs of the Wistar Institute, No. 6, Philadelphia, 1915.

[3] Slonaker, J. R., *J. Animal Behavior*, 1912, II., 20.

Rat	Stunting Period Began at: Age	Stunting Period Began at: Weight, Gm.	Growth Resumed at: Age	Growth Resumed at: Weight, Gm.	Brood I: Age	Brood I: No. in Litter, Born	Brood I: No. in Litter, Survived	Brood II: Age	Brood II: No. in Litter, Born	Brood II: No. in Litter, Survived	Brood III: Age	Brood III: No. in Litter, Born	Brood III: No. in Litter, Survived	Brood IV: Age	Brood IV: No. in Litter, Born	Brood IV: No. in Litter, Survived	Brood V: Age	Brood V: No. in Litter, Born	Brood V: No. in Litter, Survived	Brood VI: Age	Brood VI: No. in Litter, Born	Brood VI: No. in Litter, Survived	Death: Age	Death: Cause
2031 ♀	1 mo. 13 da.	48	17 mo. 21 da.	108	23 mo. 19 da.	4	4	25 mo. 21 da.	5	5	28 mo. 5 da.	3	2										32 mo. 18 da.	Lung disease
2339 ♀	1 mo. 8 da.	48	13 mo. 0 da.	104	17 mo. 17 da.	8	6	19 mo. 23 da.	9	9	22 mo. 11 da.	8	8	28 mo. 9 da.	1	0	29 mo. 20 da.	6	6	31 mo. 25 da.	2	0	32 mo. 15 da.	Lung disease
2369 ♀	1 mo. 15 da.	79	12 mo. 15 da.	103	16 mo. 23 da.	12	12	19 mo. 2 da.	7	6	21 mo. 7 da.	12	12	25 mo. 9 da.	2	2							27 mo. 17 da.	Lung disease
2446 ♀	1 mo. 13 da.	90	6 mo. 4 da.	90	16 mo. 0 da.	7	7	18 mo. 0 da.	3	1	20 mo. 19 da.	10	9	25 mo. 9 da.	5	0							26 mo. 10 da.	Lung disease

fertile. According to Donaldson[2] the menopause normally occurs at the age of 15 to 18 months, although he reports one female which, mated at the age of 22 months, produced a litter of one. The young was not reared, however.

Four of our stunted females were mated at various times. The results are summarized in tabular form. Data regarding their early stunting and subsequent resumption of growth have been published elsewhere.[4] In every case the female was not remated until some time after the birth of a litter, as the maximum number of broods which she could bear was of much less interest than the final age at which she was capable of producing young. Although none of these rats began breeding until they had reached an age when normal rats are commonly believed to be approaching the menopause, they produced from three to six litters of young and successfully reared all but a few of them. Their young were apparently as vigorous as those born of younger mothers. Hence the menopause has been postponed long beyond the age at which it usually appears. In view of this, and the added fact that less than one third of our stock rats have reached an age of more than two years, whereas all of these stunted females lived longer, it appears as if the preliminary stunting period lengthened the total span of their life.

THOMAS B. OSBORNE,
LAFAYETTE B. MENDEL,
EDNA L. FERRY
CONNECTICUT AGRICULTURAL EXP. STATION
AND SHEFFIELD SCIENTIFIC SCHOOL,
NEW HAVEN, CONN.

THE MATHEMATICAL ASSOCIATION OF AMERICA

THE second annual meeting of the Mathematical Association of America was held at Columbia University, New York City, on Thursday, Friday and Saturday, December 28–30, 1916, in affiliation with the American Association for the Advancement of Science. There were 184 persons present at the various meetings, including 141 members of the association. The first meeting was a joint session

[4] Osborne, T. B., and Mendel, L. B., *J. Biol. Chem.*, 1915, XXIII., 439; *Am. J. Physiol.*, 1916, XL., 16.

with the American Mathematical Society, Section A of the American Association, and the American Astronomical Society. At this session Professor Ernest W. Brown, the retiring president of the society, gave his retiring address on "The Relations of Mathematics to the Natural Sciences." This was followed by the retiring address of Professor A. O. Leuschner, vice-president of Section A of the American Association, on "Derivation of Orbits—Theory and Practise." A joint dinner of these four organizations was held Thursday evening, following which speeches were made by Professor Florian Cajori, President R. J. Aley, Mr. William Bowie, Professor J. A. Miller, Mr. G. A. Plimpton, and Professor Dunham Jackson.

The meeting on Friday morning was first addressed by Professor Florian Cajori, of Colorado College, who read a paper on "Discussions of Fluxions from Berkeley to Woodhouse." Professor M. W. Haskell, of the University of California, gave a paper entitled "University Courses in Mathematics Intended for Teachers of Secondary Mathematics." This was followed by a discussion led by Professor J. W. Young, of Dartmouth College, and Professor Edward Kasner, of Columbia University. During the time between the morning and afternoon sessions, opportunity was afforded by Professor David Eugene Smith for the inspection of his admirable collection of portraits and medals of mathematicians. On Friday afternoon was held the meeting of institutional delegates. This department of the association was organized for the consideration of those phases of collegiate mathematics which are of an institutional character rather than of merely individual interest; such questions as entrance requirements, requirements for degrees, maintenance of libraries, etc., will properly come under this department. The program was devoted to the subject of mathematical libraries, and consisted of a paper on "A Nucleus for a Mathematical Library," by Dr. T. H. Gronwall, of New York City, and of the reading of a report from the recently appointed library committee by the chairman, Professor W. B. Ford, of the University of Michigan, with an accompanying discussion. The program closed on Saturday morning with an address on "The Mathematics of Aërodynamics" by Professor E. B. Wilson, of the Massachusetts Institute of Technology, with a discussion led by Professor A. G. Webster, of Clark University.

The annual election is conducted both by mail and in person at the meeting; in this way a total of 405 ballots was received. The list of officers elected for the year 1917 is given herewith:

President, Florian Cajori.

Vice-presidents, Oswald Veblen, D. N. Lehmer.

Secretary-Treasurer, W. D. Cairns.

Members of the executive council to serve until January 1920, E. R. Hedrick, Helen A. Merrill, R. E. Moritz, D. E. Smith.

E. V. Huntington was chosen by the council to fill the vacancy caused in the council by the promotion of Professor Cajori to the presidency.

Fifteen persons and sixteen institutions were elected to membership; thus 1,064 individuals (deducting the number of those who have died during 1916) and 76 colleges and universities of the United States and Canada now hold membership in the association. Applications from thirteen individuals and one institution have been received since the New York meeting.

The association has a system of sections organized by the members of the various groups, mostly those within state lines. Such sections now exist in Kansas, Ohio, Missouri, Iowa, Indiana, Kentucky and Minnesota, with a section covering Maryland, the District of Columbia, and Virginia.

The report of the treasurer showed that a fund of $958.72 had been transferred to the association from the former management of the *American Mathematical Monthly*, and that the business for the year 1916 closed with a balance of approximately two hundred dollars.

An important arrangement has been entered into by the association with the *Annals of Mathematics*, which bids fair to exert an important influence upon the development of collegiate mathematics, in that it will foster the production and publication of articles of an expository and historical nature. In consideration of a subvention from the association, the board of editors of the *Annals* will increase the size of the magazine from 200 pages (its present size) to 300 pages annually, beginning with the number for June, 1917. The subscription price for individual members of the association will be one half of the ordinary price, which latter will be three dollars instead of the present price, two dollars.

The summer meeting of the association will be held by invitation of Case School of Applied Science and Western Reserve University at Cleveland, Ohio, on September 6 and 7, in conjunction with the meeting of the American Mathematical Society, with which the association has rightly so much in common. The next annual meeting will be held by invitation at the University of Chicago next December, in connection with the meeting of the Chicago Section of the society.

W. D. Cairns,
Secretary-Treasurer

SCIENCE

FRIDAY, MARCH 30, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-On-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

INDUSTRIAL MUSEUMS AND EFFICIENCY[1]

ART and natural history are now represented in New York City by material equal to that collected in any of the chief centers of the Old World. More characteristically American, however, would be an adequate showing of our astounding agricultural, mineral and industrial wealth. The proper illustration of this could and should be given by a group of special museums, united under a common management, and working in thorough harmony for the common aim of national education. The special museums should be devoted to the following branches, each one of the institutions being complete in itself:

Electricity	Historic records
Steam	Health and hygiene
Astronomy and navigation	Textiles
Safety appliances	Ceramics and clays
Aviation	Architecture
Mechanical arts	Scenic embellishment
Agriculture	Horticulture
Mining	Roads and road-building materials
Labor	Commerce and trade
Efficiency	Printing and books

Fifty years ago there was no art museum, and no museum of natural history in this great city of New York. At the present time we have both, as well as a museum of safety, but the only technical art museum is that associated with the Cooper Union for the Advancement of Science and Art. This is a small, unique and valuable technical art museum founded by and

[1] From the address of the vice-president and chairman of Section I, Social and Economic Science, American Association for the Advancement of Science, New York meeting, December, 1916.

under the direction of the Misses Hewitt.

Industrial technical museums would give not only the employer and the foreman, but each workman, a knowledge of, and create an interest in his profession or trade, no matter how humble it may be. How many men know anything about the history, the development, the successive stages of the profession in which they labor or the material with which they work? How many bricklayers know anything about the origin of a brick, how it ought to be laid, how it will best hold? How many cement-mixers are there that thoroughly understand the fundamentals of cement and mortars, how they are made, and where obtained? Few carpenters and cabinet-makers know more than one or two woods, and those not thoroughly; whether a wood can be stained, or oiled; whether it is adapted to indoor work or outdoor work. Leather, one of our greatest commodities, is understood no better.

These, and all the lines of mechanics, electricity, etc., should be illustrated in such a way that the artisan would become more skilled. The result would be to raise the amount of his production, increase his earning capacity and make him less of a clock-time server. The production of the country would be correspondingly increased, greater resources being created with less effort. One should understand the industrial conditions of the country; where the resources are, and where they can be developed. Not only nations in Europe understand this about their neighbors, but some Asiatic countries as well.

In the preparedness for peace, we find a splendid field for the utilization of our projected museum of peaceful arts. There is a growing tendency to broaden and diversify our school system, by the introduction of many elements of instruction outside of the narrower school course and the school precincts, and this has found expression in the Gary plan, so successfully introduced in many places. Our museum of the peaceful arts would enable us to give a wide development to this phase of education. For we know that nothing impresses a child or a young person more strongly than a direct visual appeal. A complete concrete object set before children, adequately explained and, if possible, set to do its work before their very eyes, will be not only better understood by them, but also far longer remembered, than any woodcut with a text-book elucidation can possibly be.

This real grasp of the matter will prove of inestimable importance when the young person begins to undertake practical work in the industrial or art calling which has been chosen. The rate of progress will be much more rapid and exact practical results will be much sooner attained than under the old system.

As so much depends upon the expansion of our foreign trade, especially in South America and in Asia, a great desideratum is that a certain number of our young men should be given a special training in this direction. Such a training could be best acquired by means of a commercial school-ship, which would make semi-annual trips to various parts of the world, stopping for a longer or shorter time at the principal foreign ports. The commercial students, under the direction of competent instructors in the various branches of trade, would thus have the opportunity to study all the commercial proceedings at first hand from actual observation. They could learn in the most impressive way all the difficulties encountered in passing goods through the various foreign custom-houses, how the goods should be packed, in what shape the foreign importer most likes to receive them, and what are the rules and practises of our

chief rivals in the export trade. "Book-learning" is singularly inefficient in such matters, however competent may be the writers of manuals and guides; only actual contact with actual conditions will ever impart the kind and quality of knowledge that go to build up a thoroughly successful export business. The pleasant conditions of such a trip, the bracing and animating effect of the pure ocean air in transit from port to port, during which the students would have ample time to think over and note down what had been learned, would make this an unforgettable period in any young man's life, a period in which the foundations of his future success had been laid.

FERTILIZER AND NITRATES—DRAINAGE AND IRRIGATION

Two great problems in the United States to-day are: First, Is not our land throughout the entire country gradually becoming poorer? Is not our yield per acre becoming less, except in a small percentage of the land where modern methods have been used? The second problem regards the fact that the great cities of the country are taking the product of the land and returning none of it to the land, only piling up garbage heaps which even when burned are lost to the land whence the original material was taken.

In regard to the waste of valuable fertilizers in the disposition of the refuse of our great city of New York, the present speaker, in 1912, used the following words in a paper read at a meeting of the American Museum Association in New York:[2]

Here in the city of New York we are permitting 2,500,000 tons of refuse and human waste to go to the garbage heaps, to the sewers, and to pollute the rivers, at once spoiling a valuable source of food supply, and bringing disease to the inhabitants of the city, while if this material could be collected and spread over the barren fields of Long Island and New Jersey, these tracts might be made into garden spots of the earth. Furthermore, these same chemical products, after being turned into food and again into waste, could be utilized anew, thus constituting a kind of endless chain of usefulness. Furthermore, the waste of nitrates in urine alone represents over 50,000 tons annually.

The unfavorable report of the United States Geological Survey on the nitrate deposits of this country clearly shows that in case of a sudden large demand arising from a state of war, this country must depend either upon the Chilean nitrate deposits, or upon nitrate derived from the atmosphere. The National Defense Act of June 3, 1916, contains an appropriation of $20,000,000 for the establishment of a plant for this purpose, and the European war has shown that a belligerent cut off from outside sources of supply can obtain at least part of the absolutely necessary nitrate, both for munitions and for agricultural fertilization, from the nitrogen in the air, although it has recently been stated on high authority that the great exponent of efficiency in Europe has been unable to provide a sufficiency for land fertilization, and that the productivity of the land is therefore decreasing rapidly.

If the United States government would establish three or more large depots of nitrate, so located as to be within easy reach of the various great agricultural complexes, storing a million tons or more in each one, the farmers would be able to supply their wants at will, and the government would be able to stabilize the price of the nitrate sold to them. The stocks could be constantly replenished, and would thus at once serve as a source of supply for agriculture, and also at a reserve for use in case of a possible war, when the boasted

[2] Presented by Dr. George F. Kunz at the International Conference relating to Program for Celebration of the Centenary of the Signing of the Treaty of Ghent, held in New York, May 9, 1913; p. 3 of reprint.

freedom of the seas might be again subjected to violation.

The increased productiveness of the farm land would render it possible in case of war to enroll probably one third of the agricultural laborers in the army, or should their services not be needed, to use them for industrial enterprises or for the cultivation of additional land. How greatly the employment of nitrates as fertilizers has been increased in recent years is shown by the fact that while in the three-year period 1898–99, 10 per cent. of the nitrate of soda used in the United States was thus utilized, the figures for 1910–12 show an average agricultural use of 45 per cent., and in 1914 the percentage had risen to 55 per cent.

The necessity for doing something to stabilize the prices of nitrates is shown by the wide range they have shown during the past four years. The downward and upward trend of the price per ton in this period is reported as follows:

1913	$52.00	$43.00
1914	44.50	38.00
1915	37.50	80.00
1916	80.00	85.00

Thus the price toward the end of 1916 ($85) was more than twice what it had been at the beginning of 1915 ($37.50).

It is interesting to note that nitrate from the Chilean beds was already used by the Indians in the seventeenth century, both for fertilizing purposes and in the making of gunpowder.[8] The immense quantity of nitrate now taken by the United States and by European countries appears in the following figures, giving the consumption for the three-year period, 1910–12:

United States	1,509,700 tons
Continent of Europe	4,852,180 "
United Kingdom	381,960 "
	6,743,840 tons

8 "The Nitrate Industry," by Señor Enrique Cuevas; pub. by Chilean Nitrate Propaganda, New York, 1916, p. 9.

The farmer who trusts to self-seeding of his land can use that land for pasture, but rarely for crops; whereas he who carefully sows his land, tills it, and enriches it, receives a splendid crop. As in the Parable of the Sower, some seed fell on good land, some on shallow land and rocky soil; some brought forth a hundred fold, and some blew away or was withered. So in the struggle of life, great men will sometimes arise from the lowest ranks in spite of all obstacles, but if many of these men had had some opportunities for development they would have attained their ends with infinitely less trouble and probably would have shown greater results.

The vital importance of carrying on drainage and irrigation work on an extensive scale becomes more and more apparent as the demand for agricultural products, both for home consumption and for export, becomes greater and greater. The public land still owned by the government, largely desert tracts awaiting irrigation, has been stated by Secretary Lane to have an extent of 250,000,000 acres. This constitutes a great and valuable reserve which must be utilized in the near future. For, even with the better fertilization, with the more intense cultivation so imperatively demanded, the rapid growth of our population and of the foreign demand make it necessary to enlarge our agricultural acreage to keep the prices of our stable products within reasonable bounds.

The reclamation of swamps is one of the most important problems of the present time. Many of the best lands of America are still in swamp form, and the sanitation produced if this land were reclaimed would more than pay for the work necessary, by the increased healthfulness of the country. The draining of the swamps is one of the best means of destroying the breeding places of the mosquito, and the extermination of the mosquito is one of the great

issues of the day. It was this extermination that made the Panama Canal possible, and has rendered Havana a justly favored health resort.

The acreage of unreclaimed and practically worthless swamp land in 1908, was stated by Hon. James Wilson, Secretary of Agriculture, to be 79,007,023 acres, and he estimated that reclamation would make these lands worth nearly $1,600,000,000, and that the value of their annual produce would amount to $273,000,000.

For the development of commerce, waterways play a most important part and the work done in this direction would fall in line with that carried on in drainage and irrigation. Our great natural waterways must be constantly supplemented, and their usefulness as channels of commerce must be increased. Nothing has so powerfully fostered the interior commerce of central Europe as the great canals uniting and extending the natural waterways, and in our own land we have striking examples of this. In such undertakings our citizen soldiery, with their special training, could be utilized in a way most valuable for the commercial interests of our land.

The great war has shown us what wonders scientific training can accomplish in destruction and devastation. Let us hope that the United States may continue to offer the world an object lesson of the value of peace arts, and that the magic wand of science may continue to be used by us for the works of peace, or, at the worst, for the defense of the freedom of our fair land against any and all ruthless aggression.

GEORGE F. KUNZ

SCIENTIFIC EVENTS

DECLINE OF GERMAN BIRTH RATE

THE Amsterdam correspondent of the London *Times* writes that although it is difficult to sift the truth from the reports which constantly reach Holland of increasing mortality in Germany, there is enough evidence in them to indicate a decline in the national vitality. Apart from causes connected with the war, there are others affecting the birth-rate to which attention is drawn by the German press, which comments on the "shameless" extent to which recourse is had to artificial means of restricting the natural growth of the population. Strong measures, it would appear, are being contemplated by the authorities to counteract the fatal effects of a policy of calculated sterility. In addition there is an enormous falling off in the number of marriages. In Berlin the number of marriages has been declining; in 1915 there were 16,622, and in 1916 13,966. With this decline there goes a decline of births and a large number of deaths.

The Amsterdam Bureau of Statistics in its weekly report compares the vital statistics of several large German towns with those of Amsterdam for the 10 weeks from November 5 to January 13. The following table, compiled from the Dutch figures, will be found instructive:

—	Amsterdam (Pop. 626,470)		Hamburg (Pop. 1,050,690)		Berlin (Pop. 1,798,962)	
	Births	Deaths	Births	Deaths	Births	Deaths
Nov. 5-11.....	255	126	179	403	387	744
Nov. 12-18.....	271	137	200	446	378	689
Nov. 19-25.....	259	143	118	422	415	736
Nov. 26-Dec. 2	279	131	196	417	370	715
Dec. 3- 9.....	269	167	177	534	373	705
Dec. 10-16.....	281	177	149	461	383	780
Dec. 17-23.....	253	225	219	407	376	849
Dec. 24-30.....	331	243	204	474	376	853
Dec. 31-Jan. 6	237	159	169	363	394	619
Jan. 7-13.....	271	194	178	426	377	699

It will be observed that in one week, December 24–30, the number of births in Berlin was only 45 in excess of the number in Amsterdam, although the population is only 80,000 short of three times the size of that of Amsterdam.

Two other large German cities are included in the comparative statistics of the Amsterdam Bureau. They are Leipzig and Dresden. Leipzig has a population of 676,289, or 50,000 more than the population of Amsterdam. In the week ended November 5–11 the births in Leipzig were 109, compared with 255 in Am-

sterdam. In no week did the births in Leipzig approach within 100 those in Amsterdam. Dresden, with a population of 579,536, compared with Amsterdam's 626,470, had in the first of the weeks mentioned 118 births compared with 255 in Amsterdam, the deaths in that week being exactly the same—namely, 126. The highest number of births in Dresden in the weeks mentioned was 142 and the lowest number of deaths 103, while the highest number of deaths was 198.

ANCIENT DWELLINGS IN NAVAHO NATIONAL MONUMENT, ARIZONA

MR. NEIL M. JUDD, of the United States National Museum, has left for Arizona to supervise for the Smithsonian Institution the excavation and repair of prehistoric ruins and cliff dwellings. The work will be carried on under a provision in the Indian Appropriation Act, Interior Department, for the preservation and repair of the remains of ancient dwelling places of certain American aborigines in the Navaho National Monument.

According to a bulletin of the Smithsonian Institution the Navaho National Monument comprises three large ruins located in the northern part of the Navaho Reservation, in Arizona, about 175 miles by trail north of Flagstaff. There is a road for about a third of the way, but there is little traffic from its termination to the Navaho Monument. From there the way is difficult to travel also on account of the scarcity of water in the desert to be crossed, the lack of opportunity to purchase supplies, and the steepness of the ascent near the monument which is truly in the "High Rocks," as the Hopi designate the location of their former home.

The trip requires about five days, but the route is an interesting one, for it passes through Painted Desert, a picturesque country especially attractive on account of the native legends and descriptions relating to the surroundings. Superstition Mountain, for example, where, so the Navaho stories relate, fires are to be seen on dark nights, recalls the old Snake legend which claims that all this country once belonged to the Fire God, and that they inherited it from him. In the olden days, so they relate, the inhabitants used to see lights moving around the mesas. Journeying over the recent lava beds and cinder plains to-day, it is easy for the traveller to accept the story of the early proprietorship of this burnt-out country, and attribute the fires seen there to volcanic eruptions and the glowing lava of years ago, which is quite enough to substantiate the legend. Among the fantastically eroded rocks, forming natural sculptures along the trail, are Elephant Legs, and White Mesa Natural Bridge, which lend interest en route to the Monument, as does also the Indian Village where still dwell descendants of the early inhabitants.

The ancient pueblo and cliff dwellings were first scientifically examined in 1908, by a party of which Mr. Judd was a member, led by Professor Byron Cummings, formerly of the University of Utah and now of the University of Arizona. They are supposed to be the ruins of dwellings made by the Snake people whose descendants live to-day in Hopi villages in northeastern Arizona. Some of the houses built in the cliffs are very large, measuring several hundred feet in length and include as many as a hundred rooms. Naturally, some of the original rooms are buried in fallen debris but their excavation and repair is to be carried out between now and the end of June, by Mr. Judd and his party.

The only human beings living in the neighborhood of these ruins is an Indian trader, and a few Navahos who are very superstitious. None of them will dig in the ruins fearing to evoke the wrath of the spirits of the dead, so Mr. Judd will be forced to engage white laborers at Flagstaff, probably six in number and a cook, relying on the native Navahos only for trail-making and the transportation of his supplies and building materials to the ruin where the work is to be done.

THE INDIAN SCIENCE CONGRESS

FROM an account in *The Englishman*, Calcutta, we learn that the fourth annual meeting of the Indian Science Congress opened on January 10 in Bangalore. A large and distinguished gathering of scientific men from

all parts of India is said to have been present, including the Hon. Mr. H. V. Cobb, Sir Alfred Bourne, Sir Sidney Burrard, Mr. J. Mackenna, Dr. Mackighan, Dr. J. L. Simmonson, Dr. H. E. Watson, Mr. R. H. Campbell, C.I.E., Dr. Harold Mann, Dr. T. M. Nair, Dr. E. H. Hankin. There were also a number of prominent local officials and others present.

The Maharaja of Mysore in opening the congress welcomed the members and made a short speech in the course of which he referred to the war. He said that one could not help feeling it a tragedy that science, to which the world so largely owed its progress and civilization, was being, as it were, debased in this war and used for the purpose of destroying human life. But may we not hope that good may come out of evil and that the lesson which the present war will leave behind of the appalling results of applying discoveries of science to the fast destruction of the human race, may eventually bring about a world peace by making the very thought of war abhorrent? May we not look forward to the time when science will be hailed not only as a beacon light of civilization but as the world's peacemaker? He alluded to the effect on Indian conditions of efforts made in the British Isles to develop science and trade and promote economic efficiency and said that the recent appointment of the industries commission will also doubtless help in that direction. He thought that some organization on the lines of the advisory board recently brought into existence in England, should be attempted in India, and referred to the need of further expansion of the Indian Institute of Science on its practical side.

As president of the Chemistry Section, Dr. J. L. Simonsen, of the Presidency College, Madras, said in the course of his address to that body:

I do not think that we can say that all is well with chemistry in India. I would submit for your consideration what I consider to be the four main causes of the paucity of research: (1) That in many colleges the staff are insufficiently trained. I do not intend to throw any aspersions on a hard working and worthy body of men; it was not their fault that when at college they received a training which did not fit them for higher teaching or research and for reasons which I shall mention they have had no subsequent opportunity to improve their knowledge. (2) That the majority of colleges are very much understaffed. This, in my opinion, is the most serious defect and the main cause of the present state of affairs. (3) The low rate of pay in academic posts. (4) The present method of promotion by seniority and not by merit. Of the other causes to which lack of research has from time to time been ascribed, I may perhaps mention two, namely, the want of library facilities and the want of a scientific atmosphere. I can not bring myself to believe that these are really serious factors. It is always a somewhat delicate matter to discuss the question of the pay offered in the various collegiate appointments. It appears to me, however, that unless the scale of pay is improved it will be impossible for us to attract the best intellects. The tendency for teaching and research to deteriorate is further announced by the fact that in practically all cases promotion is made by seniority and not by merit. I am quite willing to admit that in the larger services, such as the various government educational services, it will be a matter of considerable difficulty to make any change in the system, but I really can not imagine that it is beyond the wit of man to devise some more satisfactory scheme than the present one. One can but too well understand the feelings of a brilliant young investigator when he sees a colleague promoted to a higher post who has done nothing to render himself worthy of it, beyond putting in a certain number of years of service. This system must be radically altered if we are to see research really develop.

I have dealt with the question of the staffs of the colleges at some length because I feel it to be of vital importance. We have to meet in this country the same opposition as has to be met in England. The heads of colleges, the managers of schools, in short, the authorities in charge of education, have, as a rule, little or no appreciation of the importance of science or of its requirements. It is, perhaps, too late in the day for us to educate them, but we must make sure that the rising generation is not similarly steeped in ignorance. We must insist that our science shall be given a fair chance and that our schools shall not be sweated. I use this strong word with intent, but that they shall be given an opportunity for original work, for I very strongly hold the view that no man can remain a first-class teacher or inspire his students who

is not actively engaged in research. The future is in our hands, let us prove ourselves worthy.

THE GORDON McKAY ENDOWMENT FOR APPLIED SCIENCE

In the *Harvard Alumni Bulletin* the situation in regard to the McKay bequest is reviewed. It was a little more than three years ago that the agreement of cooperation between Harvard University and the Massachusetts Institute of Technology for instruction in the field of the engineering sciences was announced. The funds for putting these plans into effect are drawn from the great bequest of Gordon McKay to Harvard University, made for the purpose of establishing a school of applied science. This fund is held by trustees who, under the terms of Mr. McKay's will, have already transferred about two million dollars to the university and are expected, on the death of all the annuitants provided for, to bring the total payments to $22,-000,000. The cooperative arrangement between Tech and Harvard was no sooner made known than the McKay trustees, of whom the late James J. Myers, '69, was one, objected to it on the ground that it would not fulfil the wishes of Gordon McKay, who might have bequeathed his fortune to Technology, but deliberately committed it to Harvard instead. Accordingly the plan of cooperation has been put only into provisional practise in the new buildings of Technology. To ascertain whether the arrangement could be made permanent, the Harvard authorities, after introducing certain changes into the agreement, designed to meet some of the objections of the McKay trustees, petitioned the Supreme Court of Massachusetts to pass upon the legality of the arrangement.

The case has now come before Judge Pierce of that court for a hearing to determine the facts on which the court's interpretation of the law must be based. Charles F. Choate and Mr. John G. Milburn, of New York, appeared as chief counsel, respectively, for Harvard University and the McKay trustees. There was much reading of documents. President Eliot, President Lowell, President Maclaurin of the Institute, and Mr. Frank F. Stanley, one of the trustees, appeared as witnesses. The testimony presented bore upon the history of the negotiations between Harvard and Tech, and of instruction in applied science at Harvard; also upon the method and extent of the control secured to Harvard, under the agreement, in the expenditure of the McKay bequest. The hearing lasted three days. In due time the case will go to the full bench for argument.

The provisions of Mr. McKay's will include the following:

The net income of said endowment shall be used to promote applied science:

First. By maintaining professorships, workshops, laboratories and collections for any or all of those scientific subjects, which have, or may hereafter have, applications useful to man, and

Second. By aiding meritorious and needy students in pursuing those subjects.

Inasmuch as a large part of my life has been devoted to the study and invention of machinery, I instruct the president and fellows to take special care that the great subject of mechanical engineering in all its branches and in the most comprehensive sense, be thoroughly provided for from my endowment.

I direct that the president and fellows be free to provide from the endowment all grades of instruction in applied science, from the lowest to the highest, and that the instruction provided be kept accessible to pupils who have had no other opportunities of previous education than those which the free public schools afford.

I direct that the salaries attached to the professorships maintained from the endowment be kept liberal, generation after generation, according to the standards of each successive generation, to the end that these professorships may always be attractive to able men and that their effect may be to raise, in some judicious measure, the general scale of compensation for the teachers of the university.

I direct that the professors supported from this endowment be provided with suitable assistance in their several departments, by the appointment of instructors of lower grades, and of draughtsmen, foremen, mechanics, clerks or assistants, as occasion may require, my desire being that the professors be free to devote themselves to whatever part of the teaching requires the greatest skill and largest experience, and to the advancement of their several subjects.

I direct that the president and fellows be free to

erect buildings for the purposes of this endowment, and to purchase sites for the same, but only from the income of the endowment.

I direct that all the equipment required to illustrate teaching or to give students opportunity to practise, whether instruments, diagrams, tools, machines or apparatus, be always kept of the best design and quality, so that no antiquated superseded, or unserviceable implement or machinery shall ever be retained in the lecture rooms, workshops or laboratories maintained from the endowment.

SCIENTIFIC NOTES AND NEWS

Dr. Alexander Graham Bell, inventor of the telephone, was awarded the Civic Forum Gold Medal for distinguished public service in New York on March 21. The presentation address was made by Dr. John H. Finley, state commissioner of education. Dr. Bell is the third recipient of the medal. It was awarded to Major General George W. Goethals in 1914, and to Thomas A. Edison in 1915.

E. W. Rice, Jr., of Schenectady, N. Y., has been nominated by the board of directors of the American Institute of Electrical Engineers as president for the coming year.

Dr. Charles D. Walcott, secretary of the Smithsonian Institution, has been elected chairman, and Dr. S. W. Stratton, of the Bureau of Standards, secretary of the military committee of the National Research Council.

A research committee to cooperate with the National Research Council has been appointed by President W. H. P. Faunce, of Brown University. The committee includes from the faculty Carl Barus, physics, Albert D. Mead, biology, Roland G. D. Richardson, mathematics, and John E. Bucher, chemistry; from the university corporation Chancellor Arnold B. Chace and Edwin Farnham Greene, treasurer of the Pacific Mills; from the alumni J. B. F. Herreshoff, of the Nichols Chemical Company, Charles V. Chapin, of the Providence board of health, John C. Hebden, of the Federal Dyestuffs Corporation and Frank E. Winsor.

Professor von Grützner has resigned as director of the Physiological Institute, Berlin, because of advanced age.

Dr. Ralph E. Hall, assistant professor of inorganic chemistry at the Iowa State College, has resigned to accept a position in the geophysical laboratory of the Carnegie Institution, Washington, D. C.

About a year ago Professor M. A. Rosanoff, of the Mellon Institute, University of Pittsburgh, and Professor W. D. Harkins, of the University of Chicago, exchanged one week's service, Dr. Rosanoff lecturing on chemical kinetics at Chicago and Dr. Harkins lecturing on the periodic law at Pittsburgh. This spring the exchange will be repeated, but extended in time to six weeks. Dr. Rosanoff has been invited to deliver at Chicago a full university course of lectures on stereo-chemistry and a briefer one on his theory of chemical reactions. At the same time, namely, from early in April to about May 12, Dr. Harkins will give a full graduate course of lectures on thermo-chemistry at the Mellon Institute and the graduate school, University of Pittsburgh.

Harrison W. Carver, who has been connected with the Carnegie Library of Pittsburgh for seventeen years and has been chief librarian there since 1908, has been appointed director of the library of the American Engineering Societies in New York City. Mr. Carver has tendered his resignation in Pittsburgh and is expected to begin his new work in April.

A third relief expedition will be sent to the Arctic this summer by the American Museum of Natural History to bring home the members of the Crocker Land expedition, which went north in 1913. The latest word of the expedition came from Dr. Hovey in a letter dated July 10, 1916, and was brought out by the *Cluette* last September. At that time all were well. The second relief ship, the *Danmark,* was reported in Melville Bay, 150 miles southeast of Capt York, on August 20, 1916. Admiral Peary and others think she probably reached North Star Bay at least and that the explorers are on board. The third vessel will be sent to Etah, leaving St. John's early in July. The committee hopes to obtain a Newfoundland sealer for this purpose and to bring

the Crocker Land expedition back to Newfoundland late in August.

DR. SIMON FLEXNER, of the Rockefeller Institute, lectured at Wellesley College, on March 9, on "The Physical Basis of Immunity."

THE Cutter lecture on preventive medicine and hygiene will be given by Dr. Ludwig Hektoen, director of the Memorial Institute for Infectious Diseases, Chicago, on April 3, at the Harvard Medical School. Dr. Hektoen will discuss "Poliomyelitis in the Light of Recent Observations."

PROFESSOR H. S. JENNINGS, of the Johns Hopkins University, is delivering a series of four Westbrook lectures on Heredity and Evolution at the Wagner Institute, Philadelphia.

GRADUATE seminars will be offered in the coming summer session of the University of California by Professor E. C. Franklin on "Non-Aqueous Solutions" and by Professor J. H. Hildebrand on "The Theory of Solubility."

ON March 8 Dr. Haven Metcalf, of the Bureau of Plant Industry, delivered an address before the department of plant pathology of the University of Wisconsin on "The White Pine Blister Rust: An Example of the Imported Plant Disease."

PROFESSOR FREDERICK C. FERRY, dean of Williams College, gave, on March 1, an address on "Present Problems of Mathematics Teachers in Secondary Schools," before the Mathematics Club of Vassar College.

JAMES ALTON JAMES, chairman of the board of graduate studies and professor of history at Northwestern University, delivered an illustrated lecture on "The Conservation of Historic Sites in Illinois" at a meeting of the Society of the Friends of our Native Landscape on the evening of March 20, at Fullerton Hall, Art Institute, Chicago.

PROFESSOR ROBERT F. GRIGGS, of the Ohio State University, lectured on March 17 before the University Club of Chicago on "The Valley of the Ten Thousand Smokes."

THE fifth annual conference of the American Association of Agricultural Editors will be held at Cornell University on Thursday and Friday, June 28 and 29. This association is made up of the editors of the agricultural colleges and experiment stations, and meets annually to exchange ideas. Among the institutions represented are the state universities of Ohio, Wisconsin, Illinois, West Virginia, Kentucky, Tennessee, Missouri, North Dakota, South Dakota, Mississippi and Minnesota; the state agricultural colleges of Iowa, Massachusetts, Maryland, Michigan, Georgia, Oklahoma and Kansas; Clemson College and Purdue and Cornell universities.

DURING the year 1916–17 the graduate courses in chemistry at the Johns Hopkins University have included a series of lectures on selected topics by chemists from other institutions. The subjects chosen have been generally of a physical-chemical nature. Those who have thus far participated in these lectures are: Professor Gilbert N. Lewis, of the University of California, who gave three lectures on the subject of free energy; Professor Harry N. Holmes, of Oberlin College, whose subject was the formation of crystals in gels; Dr. Irving Langmuir, of the General Electric Company, the structure of liquids and solids; Dr. Walter A. Patrick, of Syracuse University, who gave five lectures on colloidal chemistry.

THE Morison lectures before the Royal College of Physicians of Edinburgh were delivered on March 5 and 9 by Dr. Edwin Bramwell, the subject being The Neurology of the War. The first lecture dealt with gunshot wounds of the peripheral nerves, and the second with shell shock and some effects of head injuries.

THE Huxley lecture at the University of Birmingham is to be delivered by Professor D'Arcy W. Thompson, whose subject is "Shells."

THE death is announced at seventy-four years of age of Professor J. G. Darboux, permanent secretary of the Paris Academy of Sciences and professor of mathematics at the Sorbonne.

R. H. TIDDEMAN, from 1864 to 1902 geologist of the British Geological Survey, died on February 11, at the age of seventy-five years.

GEORGE MASSEE, for many years head of the cryptogamic department of the Herbarium of the Kew Gardens, distinguished for his work in mycology, died on February 17, at the age of sixty-seven years.

M. JULES COURMONT, professor of hygiene at Lyons, died on February 24.

W. H. H. JESSOP, a well-known English ophthalmic surgeon, died on February 16, at the age of sixty-four years.

THE death is announced of G. Paladino, professor of histology and general physiology at the University of Naples, senator of the realm, president of various scientific societies and member of numerous others in various countries, aged seventy-five years.

IT is planned to dedicate the completed laboratory building and plant houses of the Brooklyn Botanic Garden on April 19–21. There will be formal exercises, followed by a reception, on Thursday evening, April 19. Sessions for the reading of scientific papers will be held on Friday morning and afternoon, and on Saturday morning. On Friday evening there will be a popular scientific program in the lecture hall, and on Saturday afternoon a conference for teachers to consider how the Botanic Garden may become most useful to the public and private schools of the city. The public is cordially invited to the sessions on Friday and on Saturday morning.

PROFESSOR R. TRIPIER, formerly of the University of Lyons, has bequeathed to the university the sum of $40,000, the income of which is to be used to encourage works on operative medicine and pathologic anatomy. He also left a similar sum to the city of Lyons for the purchase every fifth year of some work of art.

A BILL has been introduced in the Minnesota legislature requiring the board of regents to terminate the arrangement between the University of Minnesota and the Mayo foundation.

ACCORDING to the *British Medical Journal* the city of Paris has adopted the policy of erecting in the garden of its hospitals huts for men discharged from the army suffering from tuberculosis. Some 660 beds have already been provided in this way, and huts for 1,500 more are being put up as fast as the scarcity of labor permits. A sum of £200,000 has been voted for construction, and the expense of maintenance is estimated at £120,000 a year.

THE German Congress of Internal Medicine will be held in April, 1917, under the chairmanship of Professor Minkowski. The most important subjects for discussion will be: (1) Nutrition during the war, by M. Rubner (Berlin) and F. von Müller (Munich), (2) Constitutional diseases, by F. Kraus (Berlin) and A. Steyrer (Innsbruck), (3) The rare infectious diseases of the war. War experiences in the field of internal medicine will also be discussed.

SEVERAL research fellowships in the department of preventive medicine and hygiene at Harvard University are available for the scientific investigation of food poisoning. The work may at the same time be credited towards the doctor of public health degree. Candidates should apply to Dr. M. J. Rosenau, Harvard Medical School, Boston, Mass.

LAST year Dr. Charles McIntire resigned the secretaryship of the American Academy of Medicine after twenty-five years of service. In appreciative commemoration the American Academy of Medicine decided to raise a fund, the income of which should be expended in accordance with Dr. McIntire's suggestions. As a consequence the academy now announces two prize offers, the prizes to be awarded at the annual meetings for 1918 and 1921, respectively. The subject for 1918 is "The Principles Governing the Physician's Compensation in the Various Forms of Social Insurance." The members of the committee to decide the relative value of the essays awarding this prize are: Dr. John L. Heffron, dean of the College of Medicine, Syracuse University; Dr. Reuben Peterson, professor of obstetrics and diseases of women, University of Michigan, and Dr. John Staige Davis, professor of pediatrics and practise of medicine, University of Virginia. The subject for 1921 is "What Effect Has Child Labor on the Growth of the Body?" The members of the committee to award this prize are: Dr. Thomas S. Arbuthnot, dean of

the medical school of the University of Pittsburgh; Dr. Winfield Scott Hall, professor of physiology, Northwestern University, and Dr. James C. Wilson, emeritus professor of the practise of medicine and of clinical medicine, Jefferson Medical College.

UNIVERSITY AND EDUCATIONAL NEWS

"Gilman Hall" has been decided upon as the name of the first unit, now being built at a cost of $220,000, of the future group of permanent buildings for chemistry at the University of California. This name was chosen by the regents in honor of Daniel Coit Gilman, president of the University of California from 1872 to 1875, to whose initiative was due the organization of the college of chemistry of the university, and who in his later career as president of Johns Hopkins University did such notable service to the development of opportunities in the American universities for training for scientific research.

Goucher College has announced the completion of a "Supplemental Endowment Fund" of $1,000,000, one fourth of which was conditionally subscribed by the General Education Board. Nearly half of the entire amount has already been paid in.

A bill introduced into the Illinois legislature proposes expenditures for the medical department of the University of Illinois amounting to $2,000,000 during the next decade.

Mrs. Alexander F. Morrison, formerly president of the National Association of Collegiate Alumnæ, has given $1,500 to the University of California for the purchase of an ophthalmological library of 486 volumes for the University of California medical school.

Mrs. Roscoe R. Bell, of Brooklyn, has given the valuable library on comparative and veterinary medicine belonging to the late Professor Roscoe R. Bell, to the Alexandre Liautard Library of New York University.

Dr. Ellsworth Huntington, who resigned from Yale University several years ago to devote his entire time to research work, will become officially connected with the university again next year as a research associate in geography. Dr. Huntington will make his headquarters in New Haven and will give every year a course of lectures on his investigations, which cover a broad field that has to do particularly with the effect of climatic changes on the course of civilization.

There has been appointed at the Massachusetts Institute of Technology a committee of the faculty to consider ways of improving the methods of instruction and Dr. Charles R. Mann has been called to the institute to be chairman of the committee. Dr. Mann is professor of physics in the University of Chicago, but for the past two years has been on leave of absence to make a report on engineering education under the auspices of the Carnegie Foundation for the Advancement of Teaching.

DISCUSSION AND CORRESPONDENCE

MORE "MOTTLE-LEAF" DISCUSSION

In a recent paper Briggs, Jensen and McLane[1] discuss the situation with regard to "mottle-leaf" in citrus trees based on certain observations which they have made on orchards located in southern California. The undersigned has read their statement with the greatest interest and desires in the friendly spirit of a scientific colleague to make some comments thereon by way of broadening the discussion.

1. In reviewing the causes which have been given in the past for the production of "mottle-leaf" conditions, the authors above named mention the theories of Smith and Smith[2] and of Thomas[3] but say nothing of that promulgated in 1914 by the undersigned[4] which still seems to me to be the most definite and reasonable hypothesis for explaining the conditions in question in citrus trees.

2. Briggs, Jensen and McLane have pointed out that about half of the "mottling" is associated with soil conditions in which humus is

1 *Jour. Agr. Res.*, Vol. 6, No. 19, p. 721, August, 1916.

2 *Calif. Agr. Expt. Sta. Bull.*, No. 218, pp. 1139–1911.

3 *Calif. Agr. Expt. Sta. Circ.*, 85, 1913.

4 Science, N. S., Vol. 39, No. 1011, p. 728, May, 1914.

deficient, but this, it seems to me, gives no justification for the following statement, which I quote from their paper:

> An impartial statistical study of the data from the individual orange groves shows that approximately one half the mottling *can be accounted*[5] *for* by the low humus content of the soil.

3. That all or nearly all citrus soils in southern California are deficient in organic matter has long been known. But to state that half of the mottling "can be accounted for" by deficiencies of the soil in humus when the other half of the mottling is not at all accounted for seems to me to be an unusual procedure.

4. Moreover, the method employed by Briggs, Jensen and McLane for determining humus, upon which much of their discussion depends, has already been pointed out by Gortner[6] to be insecure if not entirely inaccurate. In the writer's laboratory it has also been found that intensity of color is no criterion of the amount of humus. Moreover, no one has yet proved, and there is no justification for believing that the humus portion of the soil organic matter, as determined by any of the arbitrary methods in vogue, is of any greater value to plants or to soils than the rest of the soil organic matter.

5. That as the paper under discussion points out the total nitrogen content of soils is not related to the amount of mottling should be no cause for surprise since it is the amount of "available" nitrogen as the writer has on many occasions pointed out rather than the amount of total nitrogen that should reasonably be assumed to affect plant growth. This is especially true under arid soil conditions, in which, moreover, the term "available" possesses more than the usual significance.

6. It seems to the writer that we need a theory or theories on some definite and specific cause of "mottle-leaf" in citrus trees and not a description of some general condition like a deficiency of organic matter which can affect soils in many different ways, not always in the same direction, and which besides is universally recognized to constitute the most undesirable feature of arid soils.

[5] Italics mine.

[6] "Soil Science," Vol. 2, No. 5, p. 395, November, 1916.

7. As Briggs, Jensen and McLane point out, however, something which affects chlorophyll formation in the leaves of the citrus tree is responsible for the trouble. That factor, in my opinion, is a lack of usable nitrogen, and in view of the peculiar mineral conditions of our soils, it may in many instances also be due to a lack of usable iron.

8. The writer does not wish to be understood as denying the effectiveness of a lack or of a sufficiency of organic matter in the production or eradication, respectively, of mottle-leaf in citrus trees. He does desire, however, to deny that there is anything specific about the organic matter factor, since it can affect plants in one of so many different ways; that the portion of the soil organic matter known as humus is any criterion as to the activity and value of the soil organic matter; that the "mottling of orange trees has been definitely correlated with the low humus content of the soil per se; and that soluble organic matter placed in the zone of the feeding roots promises any better for the eradication of "mottle-leaf" than the practise of green manuring which, to put it mildly, has thus far fallen far short of the expectations originally entertained for it.

9. As I have pointed out in the papers above cited, we shall probably be compelled not only to supply sufficient available nitrogen to eradicate the physiological troubles of our citrus and other crops, but we shall have to make it usable by some method of soil protection which will make it possible for roots of plants to make use of the surface soil. The most promising method of soil protection now seems to be complete straw mulching.

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LORD LISTER ON THE VALUE OF VIVISECTION

TO THE EDITOR OF SCIENCE: The enclosed rough draft of a letter to "Dr. Keen" (as the envelope was endorsed) was found among the late Lord Lister's papers by his nephew and

biographer, Sir Richman J. Godlee and is published by his consent.

W. W. Keen

My dear Sir: I am grieved to learn that there should be even a remote chance of the Legislature of any state in the Union passing a bill for regulating experiments upon animals.

It is only comparatively recently in the world's history that the gross darkness of empiricism has given place to more and more scientific practise, and this result has been mainly due to experiments upon living animals. It was to these that Harvey was in large measure indebted for the fundamental discovery of the circulation of the blood, and the great American triumph of General Anesthesia was greatly promoted by them. Advancing knowledge has shown more and more that the bodies of the lower animals are essentially similar to our own in their intimate structure and functions; so that lessons learnt from them may be applied to human pathology and treatment. If we neglect to avail ourselves of this means of acquiring increased acquaintance with the working of that marvelously complex machine, the animal body, we must either be content to remain at an absolute standstill or return to the fearful haphazard ways of testing new remedies upon human patients in the first instance which prevailed in the dark ages.

Never was there a time when the advantages that may accrue to man from investigations on the lower animals were more conspicuous than now. The enormous advances that have been made in our knowledge of the nature and treatment of disease of late years have been essentially due to work of this kind.

The importance of such investigations was fully recognized by the commissioners on whose report the act of Parliament regulating experiments on animals in this country was passed, their object in recommending legislation being only to prevent possible abuse.

In reality, as one of the commissioners, the late Mr. Erichsen, informed me, no single instance of such abuse having occurred in the British Islands had been brought before them at the time when I gave my evidence and that was toward the close of their sittings.

Yet in obedience to a popular outcry, the government of the day passed an act which went much further than the recommendation of the commissioners. They had advised that the operation of the law should be restricted to experiments upon warm-blooded animals; but when this bill was considered in the House of Commons, a member who was greatly respected as a politician, but entirely ignorant of the subject matter, suggested that "Vertebrate" should be substituted for "warm blooded" and this amendment was accepted by a majority as ignorant as himself.

The result is that, incredible as it may seem, any one would now be liable to criminal prosecution in this country who should observe the circulation of the blood in a frog's foot under the microscope without having obtained a license for the experiment and unless he performed it in a specially licensed place.

It can readily be understood that such restrictions must seriously interfere with legitimate researches.

Indeed for the private practitioner they are almost prohibitive; and no one can tell how much valuable work is thus prevented.

My own first investigations of any importance were a study of the process of inflammation in the transparent web of the frog's foot. The experiments were very numerous, and were performed at all hours of the day at my own house. I was then a young unknown practitioner; and if the present law had been in existence it might have been difficult for me to obtain the requisite licenses; even if I had got them it would have been impossible for me to have gone to a public laboratory to work. Yet without these early researches which the existing law would have prevented I could not have found my way among the perplexing difficulties which beset me in developing the antiseptic system of treatment in surgery.

In the course of my antiseptic work, at a later period, I frequently had recourse to experiments on animals. One of these occurs to me which yielded particularly valuable results, but which I certainly should not have done if the present law had been in force. It had reference to the behavior of a thread composed of animal tissue applied antiseptically for tying an arterial trunk. I had prepared a ligature of such material at a house where I was spending a few days at a distance from home, and it occurred to me to test it upon the carotid artery of a calf. Acting on the spur of the moment, I procured the needful animal at a neighboring market; a lay friend gave chloroform, and another assisted at the operation. Four weeks later the calf was killed and its neck was sent to me. On my dissecting it, the beautiful truth was revealed that the dead material of the thread, instead of being thrown off by suppuration, had been replaced under the new aseptic conditions by a firm

ring of living fibrous tissue, the old dangers of such an operation being completely obviated.

I have referred thus to my personal experience because asked to do so, and these examples are perhaps sufficient to illustrate the impediments which the existing law places in the way of research by medical men engaged in practise, whose ideas, if developed, would often be the most fruitful in beneficent results.

But even those who are specialists in physiology or pathology, and have already access to research work seriously hampered by the necessity of applying for licenses for all investigations, and the difficulty and delay often encountered in obtaining them.

Our law on this subject should never have been passed, and ought to be repealed. It serves no good purpose, and interferes seriously with inquiries which are of paramount importance to mankind. Believe me, sincerely yours. LISTER

QUOTATIONS

SCIENCE AND THE GERMAN CIVIL SERVICE[1]

THE committee of the Institution of German Engineers urges that steps should be taken by modification of the law in the Confederated States, and particularly in Prussia, by removing the obstructions of the law of 1906 concerning eligibility for the higher posts in the civil service so as to make it possible that not only lawyers, but also graduates of the technical high schools should be able to take up careers in the higher civil service.

Already before the war, after exhaustive discussions extending over many years, the demand had been expressed that candidates for the higher posts in the civil service should be given a scientific academic training, so as to enable them to have a full understanding of the conditions of public life upon which industrial questions and the requirements of trade and commerce exert a preponderating influence at the present day. The war has confronted the state with an unexpected number of new problems that have caused it to call into its service the intellect of the most diverse professions. This extension of admission to the higher careers in the civil service that has been introduced under the pressure of the circumstances of the time must be extended, the barriers that still exist in this respect must be removed, if it is to be possible to ensure the full development of the economic forces of the country after the war. It has now become an imperative necessity that the demand that has been expressed for many years by the Institution of German Engineers should be fulfilled, and that university graduates, particularly of the technical high schools, should be admitted to the higher grades of the civil service, so as to place the selection for this career on a broader basis.

Already ten years ago, on the occasion of the discussions in the Prussian Diet on the government proposals concerning the change of the course of study for law (1903), and later, after their rejection, in the discussions on the law concerning eligibility for careers in the higher civil service (1906), the government admitted readily that the training of the higher civil service officials did not correspond with the requirements of the day. The removal of this defect was unsuccessfully attempted at that time by a proposed reform of the academic curriculum, and is supposed now to have been achieved by means of the law of 1906 by measures that only take effect subsequent to the academic study. Later experience has shown that the method that has been adopted is hardly likely to be able to impart to the coming generation of state officials a special understanding of the economic processes that govern life in our days. The training of the majority of higher-grade officials in the civil service and communal bodies that has become customary and has been determined by the law consists in a secondary school education that has a particular bias towards the humanities, and a short university course which is almost exclusively composed of legal subjects.

The course of study laid down for the lawyers is at the same time, and without change, also the course of study for the officials of the civil service. This rigid connection of profes-

[1] Translation in the London *Times* Educational Supplement of a letter in favor of the opening of the German civil service to men of scientific training which has been addressed to Herr von Bethmann Hollweg by the Institution of German Engineers.

sions, that must be admitted to be very different in their practise, is unique in the whole educational system of Germany. It constitutes an inherent contradiction, and has gradually become an unsurmountable obstacle which will in all probability wreck the system that was to be built on the foundation of the law of 1906. The system of training that has been described above has created the peculiar situation that all young people who have a leaning towards any one of the numerous branches of the civil service, whether by family tradition, ideals, or special capacity, are forced, even against their inclination for science, to devote themselves completely to a legal training in order to pass the first law examination, as this provides practically the first documentary evidence obtainable for admission to a civil service career in the empire, the states, the communities, and many other posts. This route is closed to the graduates of other faculties—for instance, of all the experimental sciences—by the provisions of the above-mentioned Prussian law and of similar laws in the other German states, as well as by the custom that is developing in consequence of this law of appointing lawyers for administrative work.

In consequence of the preponderating influence that technical questions and the requirements of industry have to-day on all branches of public life and the increasing participation of the provinces, communities and towns in technical and scientific enterprises, civil servants are called upon to deal with problems the expert solution of which calls for just the type of mental equipment that is provided by the technical high schools. The greater part of the education at these institutes is not based on retrospection and definition, but is directed forwards and designed with a view to productive activity. An education among such surroundings must give at least as good a training for a civil service career as an education the principal aim of which is to classify the particular requirements of life according to legal conceptions. The knowledge of law and administration that is required by civil servants can be acquired to-day in every technical high school.

SCIENTIFIC BOOKS

The Measurement of Intelligence. By Lewis M. Terman. Houghton, Mifflin Co., New York. 1916. Pp. 362.

In the past few years the practise of what is termed "clinical psychology" has tended to outrun itself, in the sense that measurements of intellect have been demanded in all quarters, while methods were still tentative. Binet conceived the idea of measuring mental development by age levels, but he died before he could perfect his work. Binet's tests were not valid above the twelve-year level of intelligence. The tests which he offered above this level were almost universally discarded by clinical workers, as failing in their purpose. Another difficulty with the original scale lay in the fact that directions for giving the tests were not standardized. Inasmuch as the directions in giving a test constitute a very important part of the test itself, this seriously impaired the scientific value of the results obtained in testing. Moreover, in the original system no means was provided for comparing the intellectual quality of a young child with that of an older child. Obviously, for example, a retardation of one year in a child three years of age has a different meaning for diagnosis and prognosis than has a retardation of one year in a child twelve years of age. Stern had suggested the use of a relative measure of mentality, *i. e.*, the quotient obtained by dividing "mental age" by actual age, but this method never came into general use in America in connection with the original system. It is true, also, as Thorndike, Brigham and others have shown, that there were discrepancies between certain of the age levels as determined by Binet, and the "true" age levels. These discrepancies were due, no doubt, to the fact that Binet had not been able to standardize his tests on a sufficient number of subjects.

Goddard, Kuhlmann and other American elaborators of Binet did not advance much beyond the first work in these particulars. More recently Yerkes, Bridges and Hardwick in their point scale have eliminated many of the original crudities, and in their mental co-

efficient have proposed a relative measure of intelligence.

The present volume embodies the results of long and patient labor in overcoming and correcting the imperfections in the original Binet-Simon scale. Standardized tests are provided through average adult and superior adult levels, making the scale valid for the detection of "borderline cases." Standardized directions (admirably simple and natural) are given for every test. The method of scoring has been refined, so that the individual's mental status is determined by months, and the Intelligence Quotient becomes the measure of ability. This is obtained by dividing the "mental age" by the actual age. One would predict that this Intelligence Quotient (I. Q.) will be made the subject of much discussion and investigation during the next few years.

Six tests are provided for each year up through ten years, instead of four or five, as in the Goddard Revision, which has been most widely used in this country. The Stanford Revision, as the author modestly chooses to designate his work, is by no means a mere rearrangement of the old, familiar tests. The new scale is rich in original contributions, such as the vocabulary test, and the ball-in-the-field test. For these many cleverly conceived tests Terman gives much credit to his collaborators.

The time devoted to an examination according to the Stanford Revision is considerably greater than in the case of the former revisions. This will be a good thing from the point of view of everybody except administrative officers. The number of psychological examinations now expected daily of psychologists working in various public capacities, is little short of a scientific scandal.

The wide usefulness into which this volume has already come testifies to its timeliness as a treatise on the subject. The book is so written and so organized that it serves almost equally well as a text, as a manual, or as a reference. The first half is taken up with a discussion of the technique and method of measuring intelligence, and with the history of graded tests. The subject is clearly and simply presented in non-technical terms. The second half is given over to a presentation of the revised tests themselves, with the directions for giving and the method of scoring each. The necessary test material may be purchased from the publishers of the book.

It would seem inevitable that the Stanford Scale will, in general, replace all revisions of the Binet-Simon Measuring Scale for Intelligence hitherto in use in clinics and in institutions, because it is more scientific and more complete than any other which has been made available. The method of scoring by years and months of "mental age," however, may and probably will prevent its adoption by those psychologists who believe that the method of scoring by "points" is preferable.

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COLUMBIA UNIVERSITY

Telegraphy. By T. E. HERBERT. London and New York, Whittaker and Co. Third Edition. 985 pages, 630 illustrations. Cloth, nine shillings net.

This is the third and a thoroughly revised edition of an excellent handbook on British telegraphy, designed to meet the needs of the technical student and the requirements of departmental technical examinations of the staff.

The mathematics employed are quite elementary, so that no difficulties need be apprehended by the technical student in this direction. The telegraphic apparatus and plant of the British post-office system are well described and explained. A strong feature of recommendation for the book is that it enters at some length into the technique of the apparatus described, and gives practical directions as to best adjustments.

The text is divided into twenty-three chapters, respectively dealing with the following topics: Introduction, Primary Cells, Circuit Calculations, Current Measurements, Battery Testing, Resistance Measurements, Single-current Systems, Condensers, Differential Duplex, Quadruplex, Wheatstone Automatic, Bridge Duplex, A B C and Recording Instruments, The Hughes, The Baudot, The Murray,

Central-Battery Systems, Secondary Cells, Secondary-Cell Working, Repeaters, Test Boxes, Telegraph Testing, Aerial Lines, Underground Lines.

As will be seen from the above list, the plan of development opens with the elementary theory of the subject, and then proceeds with detailed descriptions of the various types of apparatus in most general use. Finally, the circuits and lines are dealt with.

A number of useful appendices on special topics are inserted near the end of the book. The index of subject-matter has been prepared with great care.

As a practical telegraphist's guide, and as an elementary text-book of the principles of wire telegraphy in Great Britain, the volume deserves high praise. A. E. KENNELLY

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE first number of Volume 3 of the *Proceedings of the National Academy of Sciences* contains the following articles:

Inferences concerning Auroras: Elihu Thomson, General Electric Company, West Lynn, Massachusetts. Auroras consist of vertical streamers which, seen from different points of perspective, give the various optical effects observed.

Application of the Laws of Action, Reaction and Interaction in Life Evolution: Henry Fairfield Osborn, American Museum of Natural History, New York City. In each organism the phenomena of life represent the action, reaction and interaction of four complexes of physico-chemical energy.

The Resistance of Metals under Pressure: P. W. Bridgman, Jefferson Physical Laboratory, Harvard University. Twenty-two metals are examined up to 12,000 kg.

The Rate of Discharge of Central Neurones: Alexander Forbes and W. C. Rappleye, laboratory of physiology, Harvard Medical School. The normal frequency of nerve impulses discharged from the ganglion cells in voluntary contraction must lie between 300 and 5,000 per second.

A Physiological Study of Noctiluca, with Special Reference to Light Production, Anesthesia and Specific Gravity: Ethel Browne Harvey, Cornell University Medical School, New York City, and department of marine biology, Carnegie Institution of Washington. These animals are able to regulate their specific gravity. Anesthetics seem to attack the mechanism of the utilization of oxygen in the absence of which light is not produced.

Physiographic Subdivision of the United States: Nevin M. Fenneman, department of geology, University of Cincinnati. The basis of division shown on the map is physiographic or morphologic. There are twenty-four major divisions, some with six to ten subdivisions.

On the Composition of the Medusa, Cassiopea Xamachana and the Changes in it after Starvation: S. Hatai, Tortugas Laboratory, Carnegie Institution of Washington.

Studies of the Magnitudes in Star Clusters, IV. On the Color of Stars in the Galactic Clouds surrounding Messier 11: Harlow Shapley, Mount Wilson Solar Observatory, Carnegie Institution of Washington. The frequency curve for colors shows great diversity of color index and general resemblance to the curve for the brighter stars in the neighborhood of the sun. A striking progression of color with decreasing brightness is shown.

The Color of the Standard Polar Stars Determined by the Method of Exposure-Ratios: Frederick H. Seares, Mount Wilson Solar Observatory, Carnegie Institution of Washington. The colors of the Polar Standards, brighter than the 13th magnitude, have been determined to about the same precision as was reached in the investigation of the magnitude scale, with an expenditure of time and labor perhaps a tenth of that in an earlier investigation.

Terracing of Bajada Belts: Charles Keyes. The feature of desert bajada-terracing, when explained upon a strictly aqueous basis, can not but lead to complete misinterpretation. It is far more largely the result of wind-action.

Relation of the Apex of Solar Motion to proper Motion and on the Cause of the Differences of its Position from Radial Velocities

and Proper Motions: C. D. Perrine, Observatorio Nacional Argentino, Córdoba.

Hydrology of the Isthmus of Panama: Brig. Gen. Henry L. Abbot, United States Army, retired. Extensive tables for rainfall, outflow, evaporation, etc., are given and discussed.

The Meteor System of Pons-Winnecke's Comet: Charles P. Olivier, Leander McCormick Observatory, University of Virginia. The elements of the meteor's orbit are determined from more than 1,000 observations.

Improvements in Calorimetric Combustion, and the Heat of Combustion of Toluene: Theodore W. Richards and Harold S. Davis, Wolcott Gibbs Memorial Laboratory, Harvard University. The improvements are: Means of effectively closing the bomb with less risk to the lining and cover; means of burning volatile liquids without loss; a method of automatically controlling the temperature of the environment; means of evaluating the incompleteness of combustion. The heat of combustion of toulene is determined as 10,155 calories (18°) per gram.

The Mass of the Electric Carrier in Copper, Silver and Aluminium: Richard C. Tolman and T. Dale Stewart. A continuation of experiments on currents produced by acceleration in metals.

The Silver Voltameter as an International Standard for the Measurement of Electric Current: E. B. Rosa and G. W. Vinal, U. S. Bureau of Standards, Washington, D. C. A summary of eight years' experimental work which has shown how the voltameter can be used as a reliable current standard and as a means of checking the constancy of the value of the Weston normal cell.

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SUGGESTIONS FOR THE DEVELOPMENT OF SCIENTIFIC LIBRARIES; WITH SPECIAL REFERENCE TO AUTHORS' SEPARATES

THE communication from Tracy I. Storer in SCIENCE for November 24, on the care of pamphlet collections, brings up a matter which has interested me for several years. It has been my task to rearrange a few scientific libraries and my privilege to consult several others, and I have found in nearly all of them considerable room for improvement, especially in the method of handling authors' separates and other pamphlets.

It seems to be a common, if not the prevailing, custom in private and semi-private scientific libraries to arrange pamphlets alphabetically by authors, as Mr. Storer recommends. This has the advantage of obviating the mental exertion of classifying them by subjects (which ought to be an important consideration with that apparently increasing class of persons who prefer to follow a mechanical routine rather than exercise judgment) and of keeping together the writings of one's friends, so that if a friend comes for a visit one can see at a glance just how many of his papers one has. But in most other respects the alphabetical arrangement is an undesirable expedient. For there is no important difference between a pamphlet and a book, and no good reason for putting a pamphlet on a different shelf from a book on the same subject (unless of course there happens to be a considerable difference in size of page or the pamphlet belongs to a series of bulletins).

Large libraries use some sort of subject classification, and this is equally desirable for small ones. When one is carrying on a particular line of research one likes to have all the literature bearing on it together as far as possible. It is out of the question to keep in mind every one who has written on a given subject, and unless a library is pretty fully catalogued (which is not usually the case with private working libraries), some pamphlets are pretty sure to be overlooked if they are not classified by subjects. Another objection to the alphabetical arrangement is that every scientist receives many pamphlets on subjects that he is not particularly interested in,[1] and with any other system than a subject classification these will always be in the way, unless they are relegated to a special "limbo."

[1] See *Torreya*, 16, 101–102, April, 1916.

Of course there will always be cases where it is difficult to decide under what head to file a pamphlet; *e. g.*, whether one on the snakes of Ireland should go with reptiles, British Isles, or mythology. But in some such cases the scale is easily turned by the owner's interests, and in others duplicates may be at hand, or obtainable on request, and can then be filed in both places. Still another plan is to make notes, on slips of paper of convenient size, or in thin note-books, of the titles of papers in serials, in other parts of the library, or in other libraries, and assemble them under their respective subjects. To provide a full series of such cross-references for a library of any size would of course be quite a task; but the references can be jotted down one at a time whenever one comes across them in reading, so that the time spent will not be missed; and their usefulness is directly proportional to their number, completeness not being essential.

If the library is catalogued the pamphlets can be numbered the same as books, whether they are kept separate or bound together in volumes of convenient size. For small special libraries it is well for the owner to devise his own classification, for the subject classifications in common use may not be detailed or up-to-date enough for his purposes. For example, Dewey's decimal system, which seems to be the favorite one with public libraries in this country, lumps geography and history together, arranges the families of plants by the Bentham and Hooker system, which was abandoned by most botanists about twenty years ago, and provides only one number (634.9) for forestry, which has become a pretty complex subject in recent years.

For taking care of the pamphlets on the shelves there are several methods, some of which are mentioned by Mr. Storer and some are not. The most logical is to put each one that is not part of a series in separate stiff covers, which can be done quickly and cheaply by means of some devices that are on the market. The principal objections to this method are that it more than doubles the bulk of the average author's separate, and unless the gum on the binding strips is supplemented by staples or stitching the pamphlet is liable to become detached from its paper cover or outer pages after a little handling. Furthermore, with thin pamphlets standing on shelves the titles can not be read without pulling them out a little way. A compromise might be made, however, by putting separate covers only on those exceeding a certain thickness, say a quarter of an inch.

Binding a number of pamphlets together, unless they belong to a closed series or are all on one subject, by the same author, and of the same size, is almost sure to lead to regrets later. For as a library grows or the owner's interests become more specialized its contents will need to be classified more and more minutely, and papers once thrown together will preferably be separated. And it is exceptional too for a bunch of independent pamphlets on the same subject to be of so nearly the same size that they can be trimmed alike to make a smooth-edged book.

For a growing collection of pamphlets on a given subject, not yet numerous enough to bind into a volume, or for current numbers of serials, there are various kinds of temporary bindings, suitable for reference libraries that have several dozen users. One of the cheapest of these consists of a pair of flexible pieces of cardboard of proper size, with two to four holes reinforced with metal eyelets near one of the vertical edges, and a small shoestring to go through the holes. Each pamphlet is then perforated with an awl, to correspond with the holes in the covers, and they are tied together with the string. The awl-holes do not weaken the pamphlets, and are scarcely noticeable after the collection is bound into a book. But such an outfit makes a rather ragged appearance, and the title can not very well be marked on the back of it. A more temporary method, that consumes less time and mutilates the pamphlets less, uses a piece of stiff paper for a cover, held on by a pair of strong spring clips. These, however, do not allow much variation in thickness, so that one using them at all must keep a large stock of assorted sizes on hand.

Pasteboard pamphlet cases of the type recommended by Mr. Storer (and also by Witmer Stone in SCIENCE for July 14, 1905, p. 53) are most convenient for private libraries and those that are used by only a few persons, all of whom can be trusted to put things back promptly and in the right places after using them. As a rule they should be large enough to hold both quarto and octavo pamphlets. (Those larger than quarto are best bound separately, for otherwise they are liable to be damaged if stood on end for any length of time.) Smaller sizes may be used to advantage for holding current numbers of octavo periodicals or bulletins, and also to contain complete volumes of the same, if the expense of binding is prohibitive and they are not likely to be used much. It is a good idea to have in each pamphlet case devoted to a particular region or subject a large envelope in which can be kept photographs, newspaper clippings and manuscript notes pertaining to that subject, for ready reference, instead of keeping such things in separate departments, as is commonly done.

I heartily endorse Mr. Storer's recommendation that all pamphlets should be marked with the date of accession; with the amendment that the practise should be extended also to periodicals, but is not important in cases where the publications are known to be several months or years old when received. Scientific publications dated a few weeks or months earlier than the facts warrant are deplorably common nowadays, and hereafter whenever the date of a book or magazine is suspected to be wrong the author, editor or publisher should be challenged to produce witnesses who can testify to having received it on or about the actual date of distribution.

Authors who order separates of their papers can lighten the burdens of librarians and other recipients considerably by insisting on a few simple precautions, until all printers of scientific publications get in the habit of doing the right thing without special orders. Some printers who ought to know better make separates by simply ripping the magazines apart, and if a paper happens to be unsymmetrically disposed with respect to the middle of a signature some of its leaves will then be separated, and must be fastened with paste or lateral staples, making a pamphlet that will not open out flat and is awkward to bind with others.

Every reprint from a serial should show on its cover or in some other appropriate place the volume number, page numbers, and date (not only year but month), so that it can be cited correctly without the original. If the original pagination is retained, as is usually (and ought nearly always to be) done, no additional statement about the page-numbers is necessary. Some reputable magazines still issue reprints without any indication of the volume-numbers, however, and such omissions encourage the common slipshod practise of giving incomplete citations in bibliographies. The volume number should be in Arabic figures, regardless of ancient traditions or the usage of the magazine, to save the reader the annoyance of translating the obsolescent Roman numerals which some periodicals still inflict on their readers.

The first page, or cover as the case may be, of a reprint should always bear the title and in most cases the author's name, besides the name of the magazine, etc. In sorting out large piles of pamphlets I have many times been provoked by having to stop and look inside one with a blank cover to see what it was about; and three times within the past year I have received from different printers (who had not previously done work for me) separates in which the article began on a left-hand page (which could not be foreseen when I read the proof) and the first page was left blank, necessitating writing the titles by hand or having it done by a local printer.

In ordering reprints from SCIENCE authors can accommodate their friends with no extra trouble to themselves (for they are given the choice) by having them made up in single-column or octavo form, unless they contain tables or diagrams that extend across both columns. For articles in SCIENCE do not usually make many pages, and if reprinted in the original quarto form they are rather thin, and easily torn or crumpled when filed in a case

with octavo pamphlets. The publishers of some other periodicals are equally accommodating, and I have had quarto and octavo reprints made from one that has folio pages, with no extra charge.

Even before an article is set up the author can take some precautions for the benefit of his readers. It would be too much of a digression to point out many of them here, for this is not an essay on how to prepare manuscripts for publication;[2] but attention might be called to one desirable reform, namely, restricting the number of joint contributions. Every book or paper by two or more authors, especially if new species are described in it, makes extra trouble for librarians, bibliographers, biographers and others, as long as a copy of it exists (which may be for several centuries). Usually most or nearly all of the writing of a joint paper is done by one of the authors, and the assistance of the other can be fully acknowledged without putting his name on the title-page. In cases where one author is much older or better known than the other the latter doubtless feels honored in having his name publicly associated with the more noted man's; but reputation is a scientist's most precious possession, and no true scientist should wish his to be mixed with any one else's. (Nearly all the great masterpieces of science are each the work of one man.)

For the benefit of librarians I will close with a protest against the common custom of discarding the covers and advertising pages of magazines when they are ready to be bound. The stock excuse for this is that it is done to save space; but few scientific libraries are so cramped for space that they can not spare a few inches more a year for advertising pages. It is very interesting to look through the outer pages of old numbers of SCIENCE, for instance, and see what text-books and apparatus were in use at a given period, and sometimes one can get valuable evidence of dates of publication in that way.[3] There is perhaps no better place than the advertising pages of the popular literary magazines to trace the historical development of bicycles, automobiles and innumerable other familiar articles.

[2] For some valuable suggestions along this line see W. M. Davis, *Pop. Sci. Monthly*, 78, 237-240, March, 1911.

[3] See *Torreya*, 7, 170 (footnote), Aug., 1907.

Covers help to locate articles in a volume quickly when one knows the month but not the page, and they often bear dates, tables of contents, and other information that is not given in the magazine proper. On the third cover page of the *American Journal of Science* for January, 1877, an important astronomical discovery was announced, but those who do not preserve the covers can trace it back only to the February number, where it was printed again on the regular pages. Early in the history of the same magazine the covers of some of the numbers bore a list of places where it was kept on sale, which is of considerable interest, including as it does some towns that have now almost disappeared from the maps.

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SPECIAL ARTICLES

EXPERIMENTS ON MOTOR NERVE REGENERATION AND THE DIRECT NEUROTIZATION OF PARALYZED MUSCLES BY THEIR OWN AND BY FOREIGN NERVES

DURING the past three years, I have been investigating the question of the physiological regeneration of motor nerves when directly implanted into paralyzed muscles, and the possibility of the reestablishment of normal neuro-motor connections. In these experiments a remarkable difference in the behavior of the muscles' own nerve and that of foreign nerve was found.

The experiments were made upon the nerves and muscles of the thighs of rabbits. For the electric stimulation a weak current from a Porter induction coil was used, and the nerves and muscles were always freely exposed, so that the effect of the direct stimulation of one or both could be carefully controlled. It is hardly necessary to state that experiments of this kind must be done with great care, that regeneration of divided nerves must be prevented when so desired by extensive resections of the nerves, and that the operator must be certain

that the muscle has been paralyzed by the division of all of its nerve supply. In all of the experiments, unless otherwise stated, the central connection of the nerves remained intact.

1. In the first series of experiments all of the branches of a nerve to a muscle were cut and then reimplanted into the same muscle. In the second series, after the wide excision of all of the nerves to a muscle, a motor nerve which supplied another muscle was cut and implanted into the paralyzed muscle.

It was found in all these experiments that after from eight to ten weeks, electric stimulation of the implanted or the reimplanted nerve was followed by a good contraction of the muscle.

Conclusion.—In agreement with Heineke, Erlacher and Steindler, direct neurotization of a muscle paralyzed by separation from its motor nerve supply is possible. After eight to ten weeks, the connections between the nerve and the muscle fibers have been reestablished.

2. Eight weeks after the resection of all of the nerves to a muscle, the wound was reopened and the muscle was examined. The muscle appeared pale and shrunken, and would not contract or would contract only very weakly upon direct stimulation by a strong electric current. A motor nerve from another muscle was then divided and was implanted into the atrophied muscle.

Eight to ten weeks later the muscle had regained its normal appearance, and electric stimulation of the implanted nerve was followed by a good contraction of the previously atrophied muscle.

Conclusion.—Neurotization of a muscle which has been deprived of its nerve supply for many weeks is possible. The muscle tissue regularly regenerates under the influence of the regenerating motor nerve which has been implanted.

3. (*a*) Into a muscle with its nerve supply intact, the motor nerve from another muscle was implanted.

Eight to ten weeks later, stimulation of the normal motor nerve to the muscle caused a good contraction, while stimulation of the implanted nerve was without result.

(*b*) The normal nerve to the muscle was then widely resected and the wound closed. When the wound was reopened eight to ten weeks later, the muscle had a normal appearance, and the normal nerves to the muscle had not regenerated. Now, however, a powerful contraction of the muscle followed the electric stimulation of the implanted nerve.

(*c*) In a few of the experiments described under (*a*) stimulation of the implanted foreign nerve caused a contraction of the muscle, but the muscle could no longer be made to contract when its normal nerve was stimulated.

Conclusions.—Hyperneurotization of a normal muscle is impossible. *A normal muscle can not be made to take on additional nerve supply.* The implanted nerve can not make any neuro-motor connections and its stimulation will usually fail to have any effect upon the muscle. *If, however, the muscle is permanently separated from its original nerves, then the implanted nerve—which had been hitherto unable to form a connection with the muscle fibers—will establish neuro-muscular connections, and electric stimulation of the nerve will soon cause normal contractions of the muscle.*

4. (*a*) The same experiment as in No. 3 (*a*) was performed, namely, the motor nerve from another muscle was implanted, and in addition the normal nerve to the muscle was cut outside of the muscle and the ends of the cut nerve at once united again by suture.

After eight to ten weeks, stimulation of the implanted nerve was without result, while stimulation of the normal nerve to the muscle (which had been divided and at once united by suture) either above or below the point of division caused a good contraction of the muscle.

(*b*) Both the foreign implanted nerve and the normal nerve to the muscle were cut and the ends of each at once united by suture.

After eight to ten weeks, electric stimulation of the normal nerve either above or below the point of division and suture, caused a contraction of the muscle. Stimulation of the implanted nerve was without effect upon the muscle.

(*c*) The normal nerve was cut near the muscle and was at once reimplanted into another part of the muscle. A foreign motor nerve was also implanted into the same muscle.

After eight to ten weeks, the muscle contracted upon stimulation of the normal (reimplanted) nerve, but not upon stimulation of the foreign (implanted) nerve.

Conclusions.—Under similar conditions, the normal nerve to a muscle will regain its motor connections with the muscle fibers and will in some way prevent a foreign nerve which has been implanted at the same time from making any effective neuro-muscular connections. It is impossible to state whether this is due to a more rapid regeneration of the normal nerve or to the fact that the regenerating normal nerve has an inhibitory influence upon the intramuscular regeneration of the foreign implanted nerve. The axis cylinders of the normal nerve to the muscle seem to be able to reestablish their former connections with the end plates or bulbs or to form new end organs more quickly or more powerfully than do those of a nerve which had belonged to a different muscle.

These experiments prove that if a muscle has once its normal nerve supply no other motor nerve is able to make neuro-muscular connections with the same muscle; and that if the normal nerve is cut and reimplanted into a muscle and at the same time a foreign motor nerve is also implanted into the same muscle, only the former will make neuro-muscular connections. The experiments are being continued.

Charles A. Elsberg

New York

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION B—PHYSICS

The recent, December 26–30, 1916, meetings of Section B of the American Association for the Advancement of Science were, as usual, held jointly with the American Physical Society. President R. A. Millikan, of the Physical Society, and Vice-president H. A. Bumstead, of the American Association for the Advancement of Science, alternately presided.

The address of the retiring vice-president of the association and chairman of Section B, Dr. E. P. Lewis, printed in full in Science, December 29, 1916, was an admirable summary of the numerous researches and important discoveries recently made in spectroscopy.

The symposium held jointly with Section C, was on the "Structure of Matter." The eight invited papers together with their formal and informal discussions occupied an entire day, and aroused exceptional interest. Indeed the interest was so pronounced that it has been decided to have as many as possible of the formal papers published in Science.

Other matters of interest to physicists were: some 60 technical papers, representing a wide range of investigations, presented and discussed at the joint meetings of Section B and the Physical Society; recent additions to the equipment of the laboratories of Columbia University; exhibits of apparatus and results loaned some by other universities, and some by manufacturers; and the usual physics dinner.

The number of physicists that attended these meetings was unusually large, but should have been even larger. No scientist can afford habitually to ignore these great gatherings of creative workers, nor can any university afford to tolerate such apparent indifference—for the reputation of a university is the reputation of its faculty and nothing more.

Just before adjourning a well-deserved vote of thanks was extended to the officers and faculty of Columbia University for their courteous hospitality that so materially had contributed to both the pleasure and the success of the meetings.

At present the officers of Section B are as follows:

Vice-president and Chairman of the Section: W. J. Humphreys, Weather Bureau, Washington, D. C.

Secretary: G. W. Stewart, State University of Iowa, Iowa City, Ia.

Member of Council: P. G. Nutting, Kodak Research Laboratory, Rochester, N. Y.

Sectional Committee: Vice-president, New York, H. A. Bumstead; Vice-president, Pittsburgh, W. J. Humphreys; D. C. Miller, one year; G. W. Stewart, two years; R. R. Tatnall, three years; W. S. Franklin, four years; C. W. Waggoner, five years. *Ex-officio:* R. A. Millikan, President, American Physical Society; A. D. Cole, Secretary, American Physical Society.

Member of General Committee: G. F. Hull, Dartmouth College.

W. J. Humphreys,
Secretary

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-On-Hudson, N. Y.

RADIATION AND ATOMIC STRUCTURE[1]

While the study of the physical and chemical properties of matter has produced our present atomic theory and furnished most of the information which is available about the way in which the myriad molecular structures are built up out of their atomic constituents, it has been chiefly the facts of radiation which have provided reliable information about the inner structure of the atom itself. Indeed, during all the years in which the dogma of the indestructible and indivisible atom was upon the stage, it was the complexity of the spectra even of simple gases which kept the physicist in the path of truth and caused him continually to insist that the atom could not be an ultimate thing, but rather that it must have a structure, and a very intricate one at that—as intricate, in Rowland's phrase, as a grand piano.

Yet the evidence of spectroscopy, though tremendously suggestive in the series relationships brought to light between the frequencies of the different lines of a given substance, was, after all, most disappointing, in that it remained wholly uninterpreted in terms of any mechanical model. No vibrating system was known which could produce frequencies related in the manner corresponding to the frequencies found even in the simplest of series, viz., the Balmer series of hydrogen. The discovery and study in the late nineties of corpuscular radiations of the alpha and beta type, with the changes in chemical properties accompanying them, merely

[1] Address of the president of the American Physical Society, New York, December, 1916.

served to confirm the century-old evidence of the spectroscope as to the fact of the complexity of the atom, and to educate the public into a readiness to accept it, without at first adding much information as to its nature. These studies did reveal, however, two types of bodies, the alpha and beta particles, as atomic constituents, though they said nothing at first as to their number, their arrangement, or their condition within the atom.

It was the study by Barkla of a radiation problem, namely the problem of the secondary X-radiations scattered by atoms, which furnished the first important evidence as to the number of electronic constituents within an atom. He found that the number of electrons which can act as scattering centers for X-rays is about half the atomic weight.[2] This conclusion was brilliantly confirmed by the simultaneous study in the Manchester laboratory of the scattering of the alpha rays in passing through matter,[3] and out of the converging evidence of these two types of research there emerged with considerable definiteness the Rutherford nucleus atom, consisting of a central, positively charged body of extraordinarily minute dimensions, its diameter being not over a ten thousandth of the diameter of the atom, surrounded in the outer regions of the latter by a number of negative electrons equal to about half the atomic weight. In this statement the "diameter of the nucleus" means the diameter of that portion of the atom which is found by experiment to be impenetrable to the alpha rays, while the diameter of the atom means the average distance of approach of the centers of two atoms in thermal encounters.

But it was again the study of a radiation problem which had to be called upon to furnish unquestionable information as to the exact value of this number, and at the same time to provide the most convincing evidence that we have of the general correctness of the conception of the nucleus atom.

In a research[4] which is destined to rank as one of the dozen most brilliant in conception, skilful in execution, and illuminating in results in the history of science, a young man but twenty-six years old threw open the windows through which we can now glimpse the subatomic world with a definiteness and certainty never even dreamed of before. Had the European war had no other result than the snuffing out of this young life, that alone would make it one of the most hideous and most irreparable crimes in history.

For the proof that there exist but 92 elements, from the lightest known one, hydrogen to the heaviest known one, uranium, and that these are built up one from the other by the successive addition of one and the same electrical element to the nucleus, this proof comes alone from Moseley's discovery (checked and extended as it has been by de Broglie clear up to uranium) that the square roots of the characteristic X-ray frequencies of the elements progress by almost exactly equal steps from the lightest observable one to the heaviest. Moseley proved this in a general way for both the alpha and the beta emission lines of the hardest characteristic X-ray of the elements, the so-called K rays, and also for the alpha and beta lines of the next softest series, the L series. De Broglie[5] and Hull[6] have recently shown that Moseley's law holds for the frequencies above which the different elements absorb the general radiation of tungsten. This critical frequency

[2] Barkla, *Phil. Mag.*, 21, 648, May, 1911.

[3] Rutherford, *Phil. Mag.*, 21, 669, May, 1911.

[4] Moseley, *Phil. Mag.*, 26, 1024, Dec., 1913, and 27, 703, 1914.

[5] de Broglie, *Compte Rendu*, 165, 87, 352, 1917.

[6] Hull, *Proc. Nat. Acad. of Sciences*, 2, 265, 1916.

coincides for each element, nearly, if not exactly, with the highest emission frequency characteristic of that element. De Broglie has measured accurately these critical absorption frequencies for all the heavy elements clear up to thorium, thus extending the K series from N = 60, where he found it, to N = 90—a notable advance. It is to be noted, however, that in going up from bromine, atomic number 35, to uranium, atomic number 92, the length of the step does change by a few per cent.

Now it is these radiating and absorbing properties of atoms and these alone which justify a series of atomic numbers differing from and more fundamental than the series of atomic weights. Our present series of atomic numbers is simply this Moseley series of steps based on square root frequencies. It is true that a series of atomic numbers coinciding with the series of atomic weights was suggested earlier, indeed 100 years earlier, by Prout, and by many others since then, and it is true, too, that changes in the chemical properties of radioactive substances accompanying the loss of alpha and beta particles led van den Broek,[7] just before Moseley's work appeared, to suggest that position in the periodic table might be a more fundamental property than atomic weight, but since this position is in some instances uncertain, and since the number of elements was wholly unknown, no definite numbers were or could be assigned to all the elements until Moseley's discovery was made, and the only evidence which we now have as to just how many elements there are between hydrogen and uranium, and as to just where each one belongs, is the evidence of the X-ray spectra. It is true that between helium, atomic number 2 and sodium, atomic number 11, we have no evidence other than the order of atomic weights, the progression of chemical properties and the number of known elements in this region to guide us in completing the table, but since in the region of low atomic weights the progression in the Moseley table is always in agreement with the progression in the periodic table there can be little doubt about the correct number of each element even in this region which is as yet inaccessible to X-ray measurements. Moseley's name must then be set over against one of the most epoch making of the world's great discoveries. And I wish to call attention to some important conclusions as to atomic structure which are rendered extremely probable by it.

The first is this: If we may assume that the ordinary law of inverse squares holds for the forces exerted by the atomic nucleus on negative electrons near it—and this time-honored law, so amply verified in celestial regions, has been fully verified for subatomic regions as well by the work done at the University of Manchester on the scattering of alpha rays—then the Moseley law that the square roots of the highest frequencies obtainable from different atoms are proportional to the nuclear charge[8] means, without any quantum theory, that the distances from the nucleus of each type of atom to the orbit of the inmost electron is inversely proportional to the charge on the nucleus, *i. e.*, to the atomic number. To see this it is only necessary to apply the Newtonian law connecting central force eE, orbital frequency n and radius a, namely,

$$\frac{eE_1}{a^2} = (2\pi n)^2 ma, \quad \text{or} \quad \frac{n_1^2}{n_2^2} = \frac{E_1}{E_2}\frac{a_2^3}{a_1^3} \tag{1}$$

and then to set as the statement of Moseley's experiment

[7] Van den Broek, *Phys. Zeit.*, XIV., 32, 1913.

[8] This is the proper statement of the Moseley law, as he himself *interpreted* his experimental results. He knew and was careful to state, that there is not an *exact* linear relation between the atomic numbers and the square roots of the frequencies, but the lack of exactness of equation (2) both as

$$\sqrt{\frac{n_1}{n_2}}=\frac{E_1}{E_2}, \qquad (2)$$

when there results at once from (1) and (2)

$$\frac{E_1}{E_2}=\frac{a_2}{a_1}. \qquad (3)$$

It may be objected that in the setting up of these relations I have made two assumptions, the one that the electrons rotate in circular orbits, and the other that the observed highest frequencies are proportional to the highest orbital frequencies. The first assumption is justified (*a*) by the fact that the recognized and tested principles of physics give us no other known way of providing a stable system, (*b*) by the experimental facts of light (Zeeman effect) and (*c*) by the phenomena of magnetism, especially the recent ones brought to light by Einstein and de Haas,[9] and by Barnett,[10] which well-nigh demonstrate the existence of permanent and therefore non-radiating electronic orbits. The exact circular form for the orbit is a secondary matter upon which, as will appear later, it is not necessary to insist. The second assumption, that the frequencies of the corresponding emission lines in the spectrum of the various atoms are proportional to the orbital frequencies, is from *a priori* considerations probable and from certain theoretical considerations to be presented later, necessary.

A second conclusion may be drawn from Moseley's discovery that the L lines progress in frequency from element to element just as do the K lines, the frequency being in each case between 1/7 and 1/8 as great. It is that, if there is a first or inmost electronic orbit, there must also be a second one in all elements the radius of which is given by (1) to be about 8⅔ or 4 times as great as that of the first.

Guided then by the newly discovered facts of X-radiations and the unquestioned laws of force between electric charges, we get our first information as to the probable positions and conditions of some at least of the negative electrons within the atom.

Again, having found the highest natural frequency which can come from any element, viz., that from uranium, it is of extraordinary interest to inquire where, according to Moseley's law (2), the highest frequency line of the K series would fall for the lightest known element, hydrogen, whose nucleus should consist of but a single positive electron. This is obtained, as shown in (2), by dividing the observed highest frequency of any element by the square of the atomic number. The shortest wave-length given out by tungsten, atomic number 74, and the only heavy element whose X-ray constants have been accurately determined, is $.167 \times 10^{-8}$ cm. according to Hull's measurements. This gives for the shortest wave-length which could be produced by hydrogen $.167 \times 10^{-8} \times 74^2 = 91.4$ $\mu\mu$. This is as close as could be expected, in view of the uncertainties in the measurements and the further fact that Moseley's steps are not quite exact, to the head of the ultra-violet series of hydrogen lines recently discovered by Lyman and located exactly at 91.2 $\mu\mu$. There is every reason to believe, too, from the form of Balmer's series, of which this is the convergence wave-length, that this wave-length corresponds to the highest frequency of which the hydrogen atom is capable. *It is practically certain, then, that this Lyman ultra-violet series of hydrogen lines is nothing but the K X-ray series of hydrogen.* Similarly, it is equally certain that the L X-ray series of hydrogen is the ordinary Balmer series in the visible region, the head of which is at 365 $\mu\mu$. In

to straightness and as to intercept may well be attributed to secondary causes. (See below.)

[9] *Verh. d. Phys. Ges.*, XVII., p. 152, 1913.

[10] *Phys. Rev.*, 6, 239, 1915.

other words, hydrogen's ordinary radiations are its X-rays and nothing more. There is also an M series for hydrogen discovered by Paschem in the ultra-red. This in itself makes it probable that there are series for all the elements of longer wavelength than the L series, and that the complicated optical series observed with metallic arcs are parts of these longer wavelength series. As a matter of fact an M series has been found for six of the elements of high atomic weight. Thus the Moseley experiments have gone a long way toward solving the mystery of spectral lines. They reveal to us clearly and quite certainly the whole series of elements from hydrogen to uranium, all producing spectra of remarkable similarity, at least so far as the K and L radiations are concerned, but scattered regularly through the whole frequency region, from the ultra-violet, where the K lines for hydrogen are found, clear up to frequencies $(92)^2$ or 8,464 times as high. There can scarcely be a doubt that this whole field will soon be open to our exploration. How brilliantly, then, have these recent studies justified the predictions of the spectroscopists that the key to atomic structure lay in the study of spectral lines. The prophets little dreamed, however, that the study of spectral lines meant the study of X-rays. But now, through this study, a subatomic world stands revealed to us in simpler form than one could have imagined. For the atoms are now seen to be, in their inner portions at least, remarkably similar structures, with central nuclei which are exact multiples of the positive electron, surrounded in each case by electronic orbits which have certainly, so far as the inner ones are concerned, practically the same relations in all the elements, the radii of all these orbits being inversely proportional to the central charge or atomic number.

So far nothing has been said about a quantum theory or a Bohr atom. The results have followed from the known properties of assumed circular electronic orbits combined with Moseley's experimental law, as he interpreted it, and supplemented by the single additional assumption that the observed frequencies are proportional to the orbital frequencies. If they suggest, however, that the experimental facts do not necessitate the quantum theory for their complete interpretation, the consideration of the energy relations involved—these have been entirely ignored thus far—reveals at once the futility of that hope, or of that fear, according to the nature of your predilections with regard to the theory of quanta. *For the experimental facts and the law of circular electronic orbits have limited the electrons to orbits of particular radii.* But the energy principle does not permit them to be so limited without a sudden or explosive loss of energy whenever the orbit is obliged to change. Suppose, for example, that a cathode ray strikes the atom and knocks out any electron from a particular orbit. When this or some other electron returns from infinity to this orbit, it must in this act adjust its energy to the only value which is consistent with this orbit and its characteristic frequency. Hence in the act of readjustment it must radiate a definite quantity of energy. Or again, suppose that the nucleus loses a beta ray through the radioactive process. Every electronic orbit must then adjust itself to the new value demanded by Moseley's law. But this it can not do if its energy is conserved. The only way to permit it to do so is to let it radiate a definite amount of energy in the act of adjustment. This suggests that each emission of a beta ray by a radioactive substance must be accompanied by a whole series of characteristic gamma rays corresponding to each changed orbit. The emission of an alpha particle, on the other hand, would require

an absorption rather than an emission of energy, since its egress diminishes rather than increases the nuclear charge. Perhaps this is why beta rays are always accompanied by gamma rays, while alpha rays are not so accompanied. This is, however, a speculation which does not immediately concern us here. The important conclusion, for the purposes of our present subject, is that Moseley's facts and unquestionable mechanics combined with our two assumptions of circular orbits and radiation frequencies proportional in different atoms to corresponding orbital frequencies, lead inevitably to the explosive emission of energy in definite quantities accompanying orbital readjustments. And there is nothing particularly disturbing or radical about this conclusion either, for we have no basis for knowing anything about how an electron inside an atom emits its radiation. The act of orbital readjustment would be expected to send out ether waves. The only difficulty lies in the conception of stable, non-radiating orbits between which the change occurs, and whether or not we can see how such orbits can exist, the experimental evidence that they do so exist is now very strong, and it is to further evidence for their existence, since that is the main point to be established if this theory of atomic structures is to prevail, that I now wish to direct your attention.

I have already mentioned some facts of magnetism and of light which support the orbital point of view. But the strongest evidence is found in the extraordinary success of the Bohr atom, which was devised before any of these Moseley relationships, which have forced us to the essential elements of the Bohr theory,[11] had been brought to light. Bohr, however, was guided solely by the known character of the line spectra of hydrogen and helium, together with the rapidly growing conviction, now dissented from, so far as I know, by no prominent theoretical physicist, that the act of emitting electromagnetic radiation by an electronic constituent of an atom must, under some circumstances, though not necessarily under all, be an explosive process. To show what is the character of this evidence, let us consider first what are the essential elements in the Bohr theory, and, second, what have been the accomplishments of that theory. Bohr's experimental starting point is the Balmer series in hydrogen, the frequencies in which are exactly given by

$$\nu = N\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \qquad (4)$$

n_1 having always, for the lines in the visible region, the value 2, and n_2 taking in succession the values 3, 4, 5, etc. As previously noted, Paschen had already brought to light a series in the infra-red in which n_1 was 3 and n_2 took the successive values 4, 5, 6, etc. Lyman's discovery, subsequent to the birth of the Bohr atom, of an ultra-violet series of hydrogen lines in which $n_1 = 1$ and n_2 takes the values 2, 3, 4, etc., is not to be regarded as a success of the Bohr atom, but merely as a proof of the power of the series relationships to predict the location of new spectral lines. To obtain an atomic model which will predict these series relationships for the simplest possible case of one single electron revolving around a positive nucleus, Bohr assumed:

A, a series of non-radiating orbits governed by equation (1). This is the assumption of circular orbits governed by the laws which are known to hold inside as well as outside the atom.

B, radiation taking place only when an electron jumps from one to another of these orbits the amount radiated and its frequency being determined by $h = A_1 - A_2$,

[11] N. Bohr, *Phil. Mag.*, 26, 1 and 476 and 857, 1913. Also 29, 332, 1915, also 30, 394, 1915.

h being Planck's constant and A_1 and A_2 the energies in the two stationary states.

This assumption gives no physical picture of the way in which the radiation takes place. *It merely specifies the energy relations which must be satisfied.* The principle of conservation of energy obviously requires that the energy radiated be $A_1 - A_2$. Also this radiation must be assigned some frequency ν and Bohr placed it proportional to the energy because of the Planck evidence that ether waves originating in an atom carry away from the atom an energy which is proportional to ν.

C, the various possible circular orbits, for the case of a single electron rotating around a single positive nucleus, to be determined by $T = \frac{1}{2}\tau h n$, in which τ is a whole number, n is the orbital frequency, and T is the kinetic energy of rotation. This condition was imposed by the experimentally determined relationship of the frequencies represented by the Balmer series.

It will be seen that if circular electronic orbits exist at all, no one of these assumptions is in any way arbitrary. Each one of them is merely the statement of the existing *experimental* situation. The results derived from them must be correct if the original assumption of electronic orbits is sound. Now it is not at all surprising that *A, B,* and *C* predict the sequence of frequencies found in the hydrogen series. They have been made on purpose to do it, *except for the numerical values of the constants involved.* It was this sequence which determined the form given to *C*. The evidence for the soundness of the conception of non-radiating orbits is to be looked for then, first *in the success of the constants* and second *in the physical significance, if any, which attaches to assumption C.* If the constants come out right within the limits of experimental error, then the theory of non-radiating electronic orbits has been given the most critical imaginable of tests, especially if these constants are accurately determinable.

What are the facts? The constant of the Balmer series in hydrogen is known with the great precision attained in all wavelength determinations and has the value 3.290×10^{15}. From *A, B* and *C* it is given by the simplest algebra as

$$N = \frac{2\pi^2 e^2 E^2 m}{h^3}. \tag{5}$$

I have recently redetermined e[12] with an estimated accuracy of one part in 1,000 and obtained again the value $4{,}774 \times 10^{-10}$, which I published in 1913. I have also determined "h" photoelectrically[13] with an error in the case of sodium of no more than $\frac{1}{2}$ per cent., the value for sodium being 6.56×10^{-27}. The value found by Webster[14] by the method discovered by Duane and Hunt is 6.53×10^{-27}. Taking the mean of these two results, viz., $6{,}545 \times 10^{-27}$ as the most probable value, we get with the aid of Bucherer's value of e/m which is probably correct to one tenth per cent. $N = 3{,}294 \times 10^{15}$, *which agrees within a tenth per cent. with the observed value.* This agreement constitutes most extraordinary justification of the theory of non-radiating electronic orbits. It demonstrates that the behavior of the negative electron in the hydrogen atom is at least correctly described by the *equation* of a circular orbit. If this equation can be obtained from some other physical condition than that of an actual orbit it is obviously incumbent upon those who so hold to show what that condition is. Until this is done it is justifiable to suppose that the equation of an orbit means an actual orbit.

Again, the radii of the stable orbits for hydrogen are given easily from Bohr's assumptions as

12 R. A. Millikan, *Proc. Nat. Acad.*, April, 1917.

13 R. A. Millikan, *Phys. Rev.*, VII., 362, 1916.

14 *Phys. Rev.*, Dec., 1916.

$$a = \frac{\tau^2 h^2}{4\pi^2 m e^4}.$$

In other words, since τ is a whole number, the radii of these orbits bear the ratios 1, 4, 9, 16, 25. If normal hydrogen is assumed to be that in which the electron is on the inmost orbit, $2a$ the diameter of the normal hydrogen atom, comes out 1.1×10^{-8}. The best determination for the diameter of the hydrogen molecule yields 2.2×10^{-8}, in extraordinarily close agreement with the prediction from Bohr's theory. Further, the fact that normal hydrogen does not absorb at all the Balmer series lines which it emits is beautifully explained by the foregoing theory, since according to it normal hydrogen has no electrons in the orbits corresponding to the lines of the Balmer series. Again, the fact that hydrogen emits its characteristic radiations only when it is ionized favors the theory that the process of emission is a process of settling down to a normal condition through a series of possible intermediate states, and is therefore in line with the view that a change in orbit is necessary to the act of radiation. Similarly, the fact that in the stars there are 33 lines in the Balmer series, while in the laboratory we never get more than 12 is easily explicable from the Bohr theory, but no other theory has offered even a suggestion of an explanation. But while these qualitative successes of the Bohr atom are significant, it is the foregoing numerical agreements which constitute the most compelling evidence in favor of the single arbitrary assumption contained in Bohr's theory, viz., the assumption of non-radiating electronic orbits.

Another triumph of the theory is that the assumption C, devised to fit a purely empirical situation, viz., the observed relations between the frequencies of the Balmer series, is found to have a very simple and illuminating physical meaning, viz., the atomicity of angular momentum. Such relationships do not in general drop out of empirical formulas. When they do we usually see in them real interpretations of the formulas—not merely coincidences.

Again the success of a theory is often tested as much by its adaptability to the explanation of deviations from the behavior predicted by its most elementary form as by the exactness of the fit between calculated and observed results. The theory of electronic orbits has had remarkable successes of this sort. Thus it predicts, as can be seen from 4, 5 and 3, the relationship which we assumed, viz., that for corresponding lines (like values of n_1 and n_2 in 4) the orbital frequencies n are proportional to the observed frequencies ν and similarly it predicts the Moseley law (2). But this latter relation, which is the only one of the two which can be directly tested, was found inexact, and it should be inexact when there is more than one electron in the atom, as is the case save for H atoms and for the He atoms which have lost one negative charge, and that because of the way in which the electrons influence one another's fields. It will probably be found to break down completely for very light atoms like that of lithium. The more powerful the nucleus, however, and the closer to it the inner orbit the smaller should this effect be. Now precisely this result is observed. The Moseley law (2) holds most accurately when tested for hydrogen and the elements of highest atomic number and much less accurately when tested for hydrogen and aluminum or magnesium. Similarly the ratio between the frequencies of the α and β lines of the K series approaches closer to the theoretical value (that for hydrogen) the higher the atomic number of the element.

Again, it is now well known that the α, β, γ lines in the characteristic X-ray spectrum are not single lines as required by the simple theory. Accordingly Sommer-

feld[15] extended Bohr equations in the endeavor to account for this structure on the basis of ellipticity in some of the orbits, and Paschen[16] by measurements on the structure of the complex helium lines has obtained so extraordinary checks upon this theory that e/m comes out from his measments to within a tenth per cent. of the accepted value.

A further prediction made by the theory and discovered as soon as looked for was the relation between the lines of two succeeding series of this sort:

$$\nu_{K_\beta} - \nu_{K\alpha} = \nu_{L_\alpha}.$$

This should hold accurately from the energy relations between the orbits whether there be one or many electrons in the atoms. I have been able to find no case of its failure, though the data upon which it may be tested is now considerable. I have also recently pointed out[17] that it is equivalent to the well-known Rydberg-Schuster law,[18] which holds quite generally among optical series. Finally, the ionizing potential of hydrogen is given by Bohr's equation as 13.54 volts while experiment yields 11.5 volts. This discrepancy in no way prejudices the theory, but rather lends it support, for the computed value is for the *hydrogen atom* while the observed value relates to the hydrogen *molecule*, which in view of the repulsions of its two negative electrons might be expected to be ionized more easily than the hydrogen atom. Similarly the computed value for helium which has lost one negative is 52.4 volts, but the helium molecule is found experimentally to be ionized at a much lower potential, viz., 20.5 volts. That Bohr computed this latter value at 27 instead of 20.5 volts is not at all serious, since he had to make very particular assumptions to get this result.

If then the test of truth in a physical theory is large success both in the prediction of new relationships and in correctly and exactly accounting for old ones, the theory of non-radiating orbits is one of the best established truths of modern physics. For the present at least it is truth, and no other theory of atomic structure need be considered until it has shown itself able to approach it in fertility. I know of no competitor which is as yet even in sight. I am well aware that the facts of organic chemistry seem to demand that the valence electrons be grouped in certain definite equilibrium positions about the periphery of the atom, and that at first sight this demand appears difficult to reconcile with the theory of electronic orbits. As yet, however, there is no necessary clash. Hydrogen and helium present no difficulties, since the former has but one valency, and the latter none. It is to these atoms alone that the unmodified Bohr theory applies, for it treats only the case of a single negative electron rotating about a positive nucleus. That the K radiations of the heavy elements are so accurately predictable from those of hydrogen indicates indeed that close to the nucleus of these elements there lie electrons to which the Bohr theory fairly accurately applies, but the radiations give us no information about the conditions or behaviors of the external electrons which have to do with the phenomena of valency and we have investigated but little the radiating properties of the atoms which possess but few electrons. A further study of the behavior with respect to X-rays of the elements from lithium, atomic number 3, to sodium, atomic number 11, may be expected to throw new light on this problem.

It has been objected too that the Bohr theory is not a radiation theory because it gives us no picture of the mechanism of the

15 *Annalen der Physik.*, 51, 1, 1916.

16 *Annalen der Physik.*, Oct., 1916.

17 *Phys. Rev.*, May, 1917, presented before American Physical Society, December 1, 1916.

18 Baly, "Spectroscopy," p. 488.

production of the frequency ν. This is true, and therein lies its strength, just as the strength of the first and second laws of thermodynamics lies in the fact that they are true irrespective of a mechanism. The Bohr theory is a theory of atomic structure; it is not a theory of radiation, for it merely states what energy relations must exist when radiation, whatever its mechanism, takes place. As a theory of atomic structure, however, it is thus far a tremendous success. The radiation problem is still the most illusive and the most fascinating problem of modern physics. I hope to discuss it at a later time.

R. A. Millikan

Ryerson Laboratory,
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GEORGE CHRISTIAN HOFFMANN

George Christian Hoffmann, formerly assistant director, chemist, and mineralogist of the Geological Survey of Canada, died in Ottawa, March 8, 1917. He was born June 7, 1837, in London, England, and studied at the Royal School of Mines under Sir Henry de la Bèche, under Hoffman, Percy, Smyth, Stokes, Ramsay, Huxley and Willis. He spent several years as chemist in research laboratories of England, and later 1861, wrought in Natal, South Africa, in the Mauritius, later again in Australia. In 1872 he joined the technical staff of the Geological Survey of Canada, Montreal, under Dr. Alfred R. C. Selwyn. Dr. Hoffmann was a fellow of the Institute of Chemistry of Great Britain, a fellow of the Royal Society of Canada and of many other distinguished bodies. He is the author of many numerous reports published by the Geological Survey of Canada and the Department of Mines. While in Australia he devoted considerable time in the phyto-chemical laboratory attached to the Melbourne Botanic Garden in Victoria; inquiries into the tanning properties of the barks of native trees; investigation into the amount of potash in various indigenous trees, besides experiments in reference to various acids, tar and other products. Besides the above enquiry into the suitability for paper-making of various fibrous substances were carried on by Dr. Hoffmann. The essential oils of certain trees, dyeing properties and coloring matter of others and researches on tea, opium and various economic products were carried out in conjunction with Baron Ferdinand Mueller, the distinguished Australian botanist. His bibliography contains valuable reports and papers of analyses and determinations of Canadian ores, minerals and economic products characterizing the rock formations of Canada and elsewhere, including rare and new species.

H. M. Ami

British Embassy,
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SCIENTIFIC EVENTS

LECTURES ON SANITARY SCIENCE AT RUTGERS COLLEGE

In connection with the recently established course in sanitary science, Rutgers College has inaugurated a series of public lectures. The list follows:

November 27. Professor Jacques Loeb, of the department of experimental biology of the Rockefeller Institute, New York City, "Regeneration."

February 5. Dr. J. G. Needham, professor of entomology, Cornell University, "Action."

February 28. Dr. G. M. Potter, of the Bureau of Animal Industry, Washington, D. C., "Abortion Diseases of Cattle."

March 7. Professor A. E. Taylor, Ph.D., University of Pennsylvania, "Agricultural Production in Germany under Blockade."

March 8. Mr. Allen Hazen, C.E., New York City, "Purification of Water Supplies."

March 14. Dr. K. F. Kellerman, associate chief of the Bureau of Plant Industry, Washington, D. C., "Relation of Algæ to Public Water Supplies."

March 19. Dr. J. F. Anderson, director of Squibb's Laboratory, New Brunswick, N. J., "Anaphylaxis."

March 21. Dr. Theobald Smith, director of the department of animal pathology of the Rockefeller Institute, Princeton, N. J., "Research in Animal Diseases with Reference to Agriculture and the Industries."

March 22. Dr. Theobald Smith, director of the department of animal pathology of the Rockefeller

Institute, Princeton, N. J., "Research in Animal Diseases in their relation to Public Health."

April 3. Dr. C. L. Alsberg, chief of the Bureau of Chemistry, United States Department of Agriculture, Washington, D. C., "The Administrative Control of our Food and Drug Laws."

April 11. Dr. J. F. Anderson, director of Squibb's Laboratory, New Brunswick, N. J., "Public Health Administration."

April 17. Dr. W. T. Sedgwick, director of the department of biology and public health, Massachusetts Institute of Technology, Boston, Mass., "Preparation for Public Health Work."

April 18. Dr. R. B. Fitz-Randolph, assistant director of the state hygienic laboratory at Trenton, N. J., "Public Health Conditions as they are in New Jersey."

April 19. Dr. R. B. Fitz-Randolph, assistant director of the state hygienic laboratory at Trenton, N. J., "Public Health Conditions as they should be in New Jersey."

April 20. Dr. V. A. Moore, dean of the New Jersey State Veterinary College, Cornell University, "Tuberculosis in Cattle with Special Reference to Infected Milk."

April 26. Dr. A. C. Abbott, director of the laboratory of hygiene of the University of Pennsylvania, Philadelphia, Pa., "Control of Transmissible Diseases."

May 3. Dr. E. G. Conklin, professor of biology at Princeton University, "Heredity and Democracy."

May 7. Dr. P. H. Mitchell, professor of physiology at Brown University, and summer director of the United States Fisheries Laboratory at Woods Hole, Mass., "Live Problems in Nutrition Research."

May 16. Mr. G. Fuller, engineer and sanitary expert, New York City, "What shall be the Limitation in the Pollution of Raw Waters so that they may be safely purified by modern Water Treatment Plants."

May 17. Mr. G. Fuller, "The Present Status of Sewage Disposal Methods."

SCIENTIFIC RESEARCH AND THE ELECTRICAL WORLD

A department of Scientific and Industrial Research will be henceforward one of the features of *The Electrical World*. The department is to be conducted by Professor Vladimir Karapetoff, of Cornell University, and has for its object the "Interchange of Ideas, Investigations Contemplated, Research Facilities Available, and Suggestions for Cooperative Work." The scope of the research section is described in the issue of March 17, as follows:

This section is started without preconceived ideas, but with a sincere desire to serve the interests of electrical research and of investigators. In it will be embraced:

1. Interchange of ideas among investigators in the electrical industry and in pure science on some important problem to be solved.

2. Questions regarding some topic in research to be undertaken.

3. Suggestions and answers to questions from those who are in a position to advise.

4. Brief reports on some electrical research in progress or results obtained.

5. Information regarding facilities available for electrical research in private, federal, technical-school or public service company laboratories.

6. Discussions and tabulations of some important research problems in the various branches of electrical industry and science with the idea of concentrating the attention of the investigators on those problems.

7. Suggestions and arrangements for cooperative research where it is superior to uncorrelated individual efforts.

Short contributions bespeaking the support of electrical research, or that tend to enhance its dignity and show its importance in the cultural standing, prosperity and safety of the country, will also be welcome.

A few experienced, skilled and competent investigators can not of themselves accomplish much, any more than a few generals without an army. A large number of young electrical engineers and physicists must be encouraged and interested in research, because from their ranks future great investigators will arise. Many will become useful assistants in research, still others will at least realize the importance of research and will encourage it when they reach positions of authority. Above all, a circle of sympathetic readers must be created who will follow research, delight in new achievements, and lend moral and material support to faithful workers. Otherwise the section will be like a major league team playing a spirited game before an empty grandstand.

This, then, is a request for cooperation from those who are interested in research, be it practical or theoretical. Let the profession know what you are doing and how you are doing it. Let us all rejoice in your triumphs, and let us lighten your difficulties or disappointments if possible. If the

task is too large for you, others may be willing to cooperate and help achieve results.

Following are some suggestions as to how you can do your share in this great and important work of inventorying and stimulating electrical research:

1. Indicate the most important problems in the branch of electrical engineering in which you specialize. These may be problems on which you are working, or suggestions for investigations by others.

2. Give a brief account or at least titles of investigations that you are conducting, or of the research recently done under your supervision. This information will be published for the purpose of bringing together those working on some problem now, and also those who may take it up later.

3. Describe briefly the experimental facilities at your disposal and the kinds of problems for which they are particularly suitable; also other facilities that you may possess, such as a large amount of data on file, a collection of pamphlets on some topic, natural advantages of location, etc.

4. Ask questions, if you have any, or express a desire to get in touch with other investigators on some topic.

5. Give your general views on electrical research and on how to encourage it and make it more productive.

A CENSUS OF CHEMISTS

Dr. van H. Manning, director of the Bureau of Mines, and Professor Julius Stieglitz, president of the American Chemical Society, have addressed a letter to American chemists asking them to fill in a blank giving information concerning their chemical experience and qualifications. The letter reads:

By request of the Council of National Defense, the Bureau of Mines, in cooperation with the American Chemical Society, will procure a roster of chemists of the United States. Data covering the qualifications, experience and skill of each chemist are desired to determine the line of duty in which he could best serve the country in time of need.

European experience has shown that nothing is more important in time of war or other national emergency than a knowledge of the qualifications and experience of the country's expert technical men. Men whose knowledge was invaluable to the production of munitions ordnance and supplies were killed in the trenches during the first months of the European war. This was due to lack of early information regarding individuals and has now been remedied in every European country. It is therefore important, especially at present, that this information be available in the United States.

You are accordingly requested, as a patriotic duty, not only to fill out the card which you will receive herewith, but to see that every chemist within your acquaintance receives one and does likewise. Additional cards will be furnished upon request. You will please check only those subjects in which you are expert, especially where you have had actual manufacturing experience. Please return the card promptly, using the enclosed franked envelope. The information received will be carefully classified, carded and indexed. Your prompt response to this matter will be very much appreciated.

SCIENTIFIC NOTES AND NEWS

At the meeting of the National Academy of Sciences, which will be held in Washington on April 16, 17 and 18, the Hale lectures will be given by Professor Edwin G. Conklin, of Princeton University, on "Methods and Causes of Organic Evolution."

The American Philosophical Society, which will hold its general meeting at Philadelphia on April 12, 13 and 14, has arranged a symposium on aeronautics. Papers will be presented by Professor A. G. Webster, of Clark University; Brigadier General George O. Squier; Dr. W. F. Durand, chairman of the National Advisory Committee for Aeronautics, and Dr. Charles F. Marvin, chief of the U. S. Weather Bureau.

The twenty-fifth anniversary of the New York Section of the American Chemical Society was celebrated with a dinner and smoker at the Chemists' Club, on March 9, 1917. The opening remarks of Chairman Matthews were followed by addresses by Provost Edgar F. Smith, of the University of Pennsylvania, on "Robert Hare"; Dr. Wm. H. Nichols on "The Early History of the Society," and Dr. E. G. Love on "The First Years of the New York Section." Dr. Charles A. Doremus presented to the Section a large steel engraving of Professor J. W. Draper, first president of the American Chemical Society.

The David Livingstone gold medal of the American Geographical Society has been conferred on Mr. Theodore Roosevelt in recogni-

tion of his scientific achievement in the field of geography of the southern hemisphere. Mr. Roosevelt addressed the meeting after the presentation.

On the evening of March 24, at a banquet given for Professor Anton Julius Carlson, fifty of his former pupils who have taken higher degrees under him presented him with a Sigma Xi key jewelled with diamonds and a memorial booklet containing the autographs of all the participants. Professor Carlson has just completed his tenth year as director of mechanical physiology at the University of Chicago.

Sir J. J. Thomson, Cavendish professor of physics at the University of Cambridge and president of the Royal Society, Sir David Prain, director of Kew Botanical Gardens, and Sir George Beilby, head of the Royal Technical College of Glasgow, have been elected trustees of the Carnegie Trust for Scottish Universities.

We learn from *Nature* that the following have been elected ordinary fellows of the Royal Society of Edinburgh: G. B. Burnside, Dr. B. Cunningham, T. C. Day, R. W. Dron, Professor A. Gibson, J. Harrison, Professor J. C. Irvine, A. King, Sir Donald Macalister, Reverend H. C. Macpherson, Lieutenant L. W. G. Malcolm, A. E. Maylard, G. F. Merson, F. Phillips, Dr. H. H. Scott, Sir G. A. Smith, Dr. J. Tait, Dr. W. W. Taylor, J. McLean Thompson, W. Thorneycroft and Professor D. F. Tovey.

Sir W. E. Garstin and Sir G. K. Scott-Moncrieff have been elected honorary members of the British Institution of Civil Engineers.

Professor C. Vernon Boys has been elected president of the London Physical Society.

Dr. Charles H. Herty, editor of the *Journal of Industrial and Engineering Chemistry,* has been elected chairman of the New York Section of the American Chemical Society.

Dr. Kenneth Taylor, formerly of St. Paul, has been appointed director of the Robert Walton Goelet Research Laboratories which are housed in the Doyen Hospital, Paris.

According to *Nature* a letter lately received from Dr. Ragnar Karsten, leader of the Swedish expedition in Ecuador, is dated El Tena, East Ecuador, October 10, 1916, and states that the expedition was then half-way along the difficult road from Quito to Napo, at which latter place and at Curaray ethnographical studies and collections would be made.

Mr. Howard F. Weiss has resigned as director of the Forest Products Laboratory of the United States Forest Service to become associated with the C. F. Burgess Laboratories, Madison, Wis.

George Herbert Palmer, Alford professor of philosophy, emeritus, in Harvard University, delivered the annual charter day address in the Greek theater of the University of California on March 23, the forty-ninth anniversary of the chartering of the University of California by the state.

The last of the Harvey Society lectures will be given at the New York Academy of Medicine, New York, on April 7, when Professor William H. Howell, of the Johns Hopkins University, will speak on "The Coagulation of the Blood."

Professor C. K. Leith, of the University of Wisconsin, has recently completed a six-weeks' course of lectures on metamorphic geology at the University of Chicago.

At the meeting of the University of Pennsylvania chapter of Sigma Xi, on March 14, Dr. William Curtis Farabee gave an illustrated address on "Some Myth Makers of the Amazon," based on his recent travels in South America, and Dr. George B. Gordon, director of the University Museum, spoke on "The Museum's Work in Exploration."

Dr. David D. Whitney, professor of zoology in the University of Nebraska, gave an illustrated lecture on "Sex Determination" before the Science Club of Kansas State Agricultural College on March 20.

Dr. Felice Ferrero, American representative of the Italian press, will give a series of three lectures on the History of Science at Harris Hall, Northwestern University. The lectures will be as follows:

Thursday, March 29. "The Period of Philosophical Speculation. Theories of Evolution and Arithmetic."

Saturday, March 31. "The Shift to Experimental Methods. Aristotle, the Naturalist, the Astronomer and the Physicist."

Monday, April 2. "The Great Lights of Ancient Science: Archimedes and Hipparchus."

THE third Guthrie lecture of the Physical Society, London, was given on March 23, by Professor P. Langevin, on "Molecular Orientation."

JONATHAN RISSER, professor of zoology at Washburn College and previously assistant professor at Beloit College, died on March 23, aged forty-eight years.

DAVID H. BROWNE, a metallurgical engineer living at Montclair, N. J., known for his work in copper smelting, died on March 30, at the age of fifty-three years.

DR. E. P. RAMSAY, curator for many years of the Australian Museum, Sydney, author of works on ornithology, has died at the age of seventy-four years.

THE death is announced, in his ninety-second year, of James Forrest, honorary secretary, and for many years the secretary, of the Institution of Civil Engineers.

GENERAL J. A. L. BASSOT, the distinguished French geodesist, has died at the age of seventy-six years.

AMONG New York State civil service examinations to be held on May 5, are examinations for the position of assistant bacteriologist in the State Department of Health, with salaries of $900 to $1,800.

THE annual meetings of the American Association of Pathologists and Bacteriologists and of the American Association of Immunologists is being held in New York City on April 6 and 7, under the presidency of Dr. Richard Weil. The sessions will be held at the New York Academy of Medicine and at the Rockefeller Institute.

THE Peabody Museum of Yale University, which for forty years has housed the Marsh collection of fossils, the Gibbs mineralogical collection, for which citizens of the city and Yale paid $20,000 almost a hundred years ago that it might not go to the city of Hartford, and other collections of more recent date, closed its doors to the public last week. With the razing of this old natural history museum will pass out of existence the building that has been the college home of many distinguished members of the Yale faculty, including James Dwight Dana, Othniel Charles Marsh, Addison E. Verrill, Sidney I. Smith and George Jarvis Brush. Visitors will have no opportunity to see the university's collections in natural history until the new museum on the Sage-Pearson plot is finished.

UNIVERSITY AND EDUCATIONAL NEWS

AT the Charter Day exercises of the University of California on March 23, President Benj. Ide Wheeler announced that the gifts of the previous twelve months amounted to approximately half a million dollars, among the principal items being the $70,000 given by Professor and Mrs. George Holmen Howison to endow a fellowship in philosophy, scholarships in English, etc.; $200,000 provided by the late Mrs. Elizabeth Josselyn Boalt to endow instruction in the school of jurisprudence; $43,-493 given by various friends of the university to furnish and equip the new University Hospital in San Francisco, a 215-bed teaching hospital, itself built through gifts of $586,000 from a number of different benefactors, and $80,000 expended during the year by the gift of Miss Ellen B. Scripps, for a new thousand-foot concrete pier, a new library and museum building, etc., for the Scripps Institution for Biological Research at La Jolla.

MR. CHARLES W. BINGHAM (Yale, '68), of Cleveland, Ohio, has given $10,000 to Yale University for the endowment of scholarships to be awarded to graduates of the high schools of Cleveland and its vicinity entering the college or the scientific school.

ALL SOULS COLLEGE, Oxford, has given the university fifteen hundred pounds in aid of the general fund and the like sum for the Bodleian Library.

DR. CHARLES A. MANN, of the University of Wisconsin, has been appointed associate professor of chemical engineering at Iowa State College, to succeed Professor George A. Gabriel, who has resigned to undertake industrial work.

AT Yale University Samuel James Record, at present an assistant professor in the Forestry School, has been elected professor of forest products, and Assistant Professor Ralph Chipman Hawley has been promoted to a full professorship of forestry.

HOWARD LILIENTHAL, M.D., (Harvard, '87), has been appointed professor of clinical surgery in the Cornell University Medical School.

MR. E. D. MERRILL, botanist in the Bureau of Science, Manila, and for the last four years associate professor of botany in the University of the Philippines and head of the department, has been promoted to the full professorship. His services will be divided between the university and the Bureau of Science as in the past.

THE resignation of Dr. E. A. Letts from the chair of chemistry in the Queen's University, Belfast, is announced.

DISCUSSION AND CORRESPONDENCE

EPICENE PROFILES IN DESERT LANDS

IN the genetic analysis of the land forms characteristic of arid regions there seems to be an inexplicable proneness to derive all relief effects not through means of the mastering erosive powers peculiarly dependent upon aridity but through the operation of the same geologic processes which produce the landscape features under conditions of normal humid climate. This far too general tendency to regard all geographic agencies as differing merely in degree and not in kind inevitably leads to erroneous conclusions concerning the origin of many relief details. Although in the instance of desert lands there are not only more but different erosional agencies to be taken into account there is actually less complexity involved than in moist lands. On the other hand while there is still the simultaneous working of several distinct processes a little-known one becomes dominant and so thoroughly ascendant as to all but completely obscure the operations of the others. To this aspect of the desert problems little attention has been heretofore devoted.

Although this exceptional simplicity of landscape derivation obtains in typically desert tracts it appears to be not nearly so prevalent either on the borders of the desert or in the penumbral semi-arid belts. In the last mentioned situation there is a notable mingling of relief effects produced by the action of several distinct erosional processes. Here recorded observation chances to be most extensive and generalization most rampant. Here, too, because of the fact that the examination of the features is attended by strong bias of moist climate experience misinterpretation of true desert characters is rife.

By inference, at least, use of the title "Epicene Profiles" applied to arid tracts, presupposes the recognition of other relief effects. The orogenic profile which has been so long inseparably associated with desert topography is at once relegated to the back-ground. By its elimination a diametrically opposed proposition is substituted for that most brilliant of geological concepts—the fault-block hypothesis of basin range structure whereby the mountain prisms are tilting and floating as do ice-cakes in a river at time of spring break-up.

The early impression that desert ranges, as those of the Great Basin for instance, are buried mountains still strongly persists. But there are many phenomena in such regions that water-action does not begin to explain. The rock-floor which many intermont basins display is one of them. The smooth plains surface of enisled landscapes at once excites greatest interest. To find such tracts areas of profound degradation instead of extensive aggradation, as one is led to expect after accepting the water-action hypothesis, is truly surprising. Whether desert tracts of this description owe their facial expression mainly to pre-arid corrasion by streams all traces of which have long since vanished, whether the sloping interment plains are the result of sheet-flood erosion, or, as is still more lately proposed, the rock-floor of desert piedmonts is due to

former stream-planation and burial by mountain wash which by stream-action at a later stage is again removed the fact remains that the finest and most extensive rock-floors are found in situations where no water-action could possibly have occurred. For all these cases other suggestions of genesis is, of course, necessary.

The local exhuming of the rock-floors of arid piedmonts by the removal of its wash mantle does not really demand any elaborate inductive reasoning in order to reach an adequate explanation of the phenomenon. It is one of the commonest features of the desert. The effect is sometimes repeated over the same district several times in a year. It has been known to take place over night—by wind action. In the semi-arid belt, or on the margin of lofty mountains, as the Sierra Nevada in California for example, the local removal of the soil layer might be at first glance ascribed to stream-action; but broader observation extending to typical desert regions, where only low hills prevail, demonstrates at once that the stream-planing hypothesis must be entirely abandoned. The extension of moist-climate principles of erosion to arid lands is done with constantly growing difficulty.

In support of the idea of the eolic derivation of many rock-floored piedmont plains there are ample published observations. The late W J McGee's descriptions of the phenomenon as displayed in Sonoran deserts are pertinent. A single experience of my own when encamped on the Jornada del Muerto at the northern end of the Mexican tableland is by no means an isolated instance. There at the foot of a mountain apparently "buried up to its shoulders in its own débris" a strong gale which suddenly arose completely swept away in a half hour's time the supposedly deep soil and laid bare the smoothest and hardest of rock-floors worn out on the upturned edges of most resistant strata. Since the situation was at the mouth of a canyon and upon the back of what appeared to be a broad alluvial fan, a day's later visit might have ascribed the phenomenon to stream work.

Charles Keyes

NOTES CONCERNING THE FOOD SUPPLY OF SOME WATER BUGS

In the literature dealing with aquatic Hemiptera, we are informed that without exception they are predatory: those which dwell upon the surface capturing such flies and other terrestrial insects as may chance to fall into the water, and those that pass their lives beneath the surface preying upon aquatic insects and similar organisms.

In the light of recent observations along this line, the above information seems inadequate. Corixids for instance are largely herbivorous.

The bulk of the food of our common water-strider, *Gerris marginatus*, consists at certain times of the year almost exclusively of the Jassids and related forms that feed on *Juncus* and other plants bordering on and growing in the shallow waters.

Our common species of *Rheumatobates*, while it does not disdain to feed upon small insects that fall into the water, obtains its main supply from the little crustacean forms such as Ostracods and Daphnians, which swarm the quiet pools. These it captures as they rest at the surface, scooping them out and holding them aloft upon the upturned tip of the beak, while the body of the little victim is being depleted of its nutritive material. A species of the genus *Microvelia* common in Kansas has access to the same source for its food supply and similar habits of consuming it. *Mesovelia mulsanti*, our little green Gerrid, has been observed exploring the sides of stems of *Juncus* and *Typha* that lay just beneath the surface for Ostracods, which they occasionally obtained, while the well-known marsh treader, *Hydrometra martini*, stalks about over the floating vegetation in search of whatever small beings chance to come to the surface film. Its victims have been observed to consist of mosquito wigglers, mosquito pupæ, emerging midges, nymphal corixids, and Ostracods, as well as small terrestrial insects floundering on the water.

Among the bugs that live in the water, none are more common than the back-swimmers, or Notonectids, and the water boatmen, or

Corixids. The former feed in their first three stages largely upon the small crustacea—Ostracods, cyclops and Daphnians, etc.,[1] adding to this diet such other forms as they are able to master, including corixids, mosquito larvæ and their own weaker brothers, while the source of the food supply of the boatmen[2] is found in the brown, sedimentary material on the bottom of the pool. This they scoop up with the flat rakes of their fore-legs. These rakes are the somewhat spoonshaped terminal segments or *palæ,* which are most admirably equipped for their work. An examination of the contents of the digestive tract reveals much of disorganized unicellular plant matter, diatoms, oscillatoria, euglenæ, chlamodomonas, and occasionally the shell of an arcella, or the remains of other lowly animal forms.

Thus, it may be noted that the Corixids can be looked upon as members of the producing class in the waters where they are found. Gathering their food from the slimy ooze at the bottom of the pool, they in turn make forage for the many predatory animals that lurk in the shadowy places or dart in pursuit of their prey. We have witnessed their capture by Notonectids, Naucorids and nymphal Belostomas, by the larvæ of Dyticids and Gyrinids, and are forced to believe that they take their place with the Entomostraca in furnishing food supply. Their alertness and agility, however, permit them to maintain themselves even in waters swarming with carnivorous forms, while in proper waters, with an absence of a dominating predatory population, they thrive in astonishing numbers.

More might be said concerning the rôle played by the aquatic Hemiptera in the society of water forms, but this will suffice to indicate that they have a part not heretofore recorded—an intimate relation to certain of the Entomostraca, and even to the unicellular life of our ponds and pools.

H. B. Hungerford
Cornell University

1 We have reared *N. undulata* to end of fourth instar in a small Petri dish, its only food being ostracods supplied to it daily by means of a pipette.

2 We have carried a species of boatmen through its entire cycle as many as twelve individuals in a single Petri dish upon such fare.

THE DOCTRINE OF EVOLUTION AND THE CHURCH

To the Editor of Science: In the minds of those who are beginning to be classed among the older men, there still lingers the memory of the time when the pulpit hurled its denouncements against those men of science who had the temerity to accept the doctrines of evolution as advanced by Darwin and Huxley.

An interesting instance of the entire change of opinion that has come over the clergy is shown by an experience that occurred at the exercises connected with the celebration of the one hundredth anniversary of the consecration of St. John's Church in Washington City on January 14, 1917.

A former rector of St. John's, the Rev. Dr. George William Douglas, now a canon of the Cathedral of St. John the Divine in New York City, in a sermon in which he reviewed the history of the church, spoke of a century as being a very short time in comparison with the time during which man had inhabited our earth, quoting Henry Fairfield Osborn's recent work on "Men of the Old Stone Age" as his authority, for the number of years.

It is a far cry to the Oxford meeting of the British Association in 1860 when the learned Bishop Wilberforce attempted so unsuccessfully to controvert Huxley, the youthful advocate of science, then well nigh unknown outside the narrow circle of scientific workers.

On Huxley's tomb are these words:

> And if there be no meeting past the grave,
> If all is darkness, silence, yet 'tis rest.
> Be not afraid, ye waiting hearts that weep,
> For God "still giveth his beloved sleep,"
> And if an endless sleep he will—so well.

Sir Michael Foster once said:

> Future visitors to the burial place [of Huxley] on the northern heights of London, seeing on his tomb the above lines, will recognize that the agnostic man had much in common with the man of faith.

It is interesting to note the fact that Osborn was a pupil of Huxley's and by chance was in

the congregation when Dr. Douglas preached his sermon.

MARCUS BENJAMIN

THE MANUFACTURE OF APPARATUS AND CHEMICALS

TO THE EDITOR OF SCIENCE: It has often occurred to me that it would be beneficial to science if some of the large universities of this country would cooperate to build a factory where chemicals and apparatus would be manufactured and sold to the various scientific institutions at a correct margin of profit. Perhaps the Rockefeller or Carnegie Foundation could be interested in such a project. The majority of fellow investigators and university professors would welcome such an arrangement, for it would make material accessible which is difficult to obtain otherwise and might be an important source of instruction to industrial chemists and physicists.

LOUIS BAUMANN

THE STATE UNIVERSITY OF IOWA

LORD LISTER ON THE VALUE OF VIVISECTION

TO THE EDITOR OF SCIENCE: In reference to the letter from Lord Lister to myself published in SCIENCE of March 30, 1917, I beg leave to make this explanation. Recently the original copy of this letter has been found. It is dated 12 Park Crescent, Portland Place, London, West, 4th of April, 1898, and addressed to myself. Just after its receipt I handed it to a friend to use in connection with the hearing before the United States Senate on the Gallinger Bill relating to animal experimentation in the District of Columbia. My friend presented it at the hearing and it is published in the pamphlet relating to that hearing.

When Sir Rickman Godlee sent me a copy of the "rough draft" of this letter not long ago, saying if it had been received he would like to publish it in his "Life of Lord Lister," I went with great care over all of my letters and could not find the original. As it was almost a score of years since it had been received I had quite forgotten it and came to the conclusion that either it had gone astray in the mails or had never been sent. It has been returned to me and I have placed it in the Library of the College of Physicians of Philadelphia.

W. W. KEEN

PHILADELPHIA, PA.,
March 31, 1917

QUOTATIONS

THE AMERICAN ASSOCIATION AND WORK IN AGRICULTURE

THE annual meeting of the American Association for the Advancement of Science is one of the great scientific events of the year. It is a vast clearinghouse for ideas and results in science, and for the testing and molding of views. It presents the largest forum in this country for healthy, tempered but searching criticism in science, without which science becomes self-complacent, lax and unexacting in its requirements.

Beyond this, such a meeting of men associated with the various branches of science has a remarkably broadening influence. One gets new insight, suggestion and inspiration from such a contact of minds, such a presentation of evidence, such a weighing and testing of results and of views. The individual finds anew that his branch of science or his specialty has relations beyond the narrow limits in which he has been considering it, and that there is not only an interest in following this broader relation, but a danger unless he does that he may specialize too closely in his thinking and view his subject out of focus.

Hence it seems worth while for the man of science to foregather from time to time with his colleagues in the annual convocation, worth the time and worth the money outlay. This is not so much to listen to papers which might be read or to present a report which might be published, but to keep his mind from narrowing, to maintain a contact with science which is well nigh impossible otherwise, and an association which contributes so much to the zeal and the satisfaction of a scientific career. It brings him definitely into membership in that great fraternity of workers in the broad field of science—some for its own sake, some for its relations to human welfare, all having the common purpose to advance knowledge and understanding. It was the belief in such advantages that led thousands of men and women to jour-

ney long distances, many from the south and the west, to attend the New York meeting.

The relation to agriculture of considerable parts of the programs of various sections and affiliated societies seems increasingly greater with each succeeding meeting. Perhaps it is because our interest is broadening. Perhaps it is because the investigation in agriculture is leading more and more deeply into the realm of the sciences. And undoubtedly it is because interest in these problems is becoming more widespread, for the problems of agriculture are now attracting the attention of very many men and women identified with nonagricultural institutions. The biological chemists, the various botanical organizations, the entomologists, the zoologists, the geneticists, the ecologists, all had papers of immediate import to agricultural investigation. Indeed, there were so many of these contributions and discussions that the difficulty was to hear more than a small part and to make a selection.—*Experiment Station Record.*

SCIENTIFIC BOOKS

Plant Succession. An Analysis of the Development of Vegetation. By FREDERIC E. CLEMENTS, Carnegie Institution of Washington, Publication Number 242, Washington, D. C., 1916. Pp. xiii + 512, 61 half tone plates of two to three figures each, and 51 figures in the text.

For nearly a quarter of a century the author of this large and attractive volume has been investigating numerous problems in the field of phyto-ecology and related subjects as he has found them in the great out-of-door laboratory of western United States. This area is particularly stimulating for such work since so many of the natural life phenomena have been preserved to the present in nearly their original conditions. During these years the author has been favored with unusual facilities for the conduction of his investigations. Because of these facts, as well as because of the well-known leadership which American ecologists enjoy, this latest work from Clements will attract the attention of botanists and biologists in general throughout the world.

The reader must understand that this work is not in any sense a treatise on general plant ecology. It represents a careful examination of the facts and principles of plant succession, an analysis of the development of vegetation in the past as well as the present, together with a digest of the methods for investigating successional phenomena.

The subject-matter of the monograph is arranged in fifteen subdivisions or chapters. In Chapter I. the author rewrites his rather familiar views as to the fundamental nature and causes of succession. He points out that "the developmental study of vegetation rests upon the assumption that the unit or climax formation is an organic entity." As a living entity this unit arises, develops, matures and eventually disappears. All such entities or formations develop as a result of succession which may occur again and again in the history of each climax unit. The most striking external feature of succession lies "in the movement of populations, the waves of invasion, which rise and fall through the habitat from initiation to climax."

An excellent historical summary beginning with King (1685) and including the work of twentieth century ecologists is included in Chapter II. This is a valuable summary of the concepts that have helped in shaping modern ideas with regard to plant succession.

Then follows a long chapter on the causes of succession. "Initial causes" are discussed under the captions: Topographic Causes, Erosion, Deposit, Elevation and Subsidence, Edaphic Causes, Climatic Causes, Biotic Causes, while "ecesic causes" are enumerated as Aggregation, Migration, Ecesis, Competition and Invasion. This chapter is followed by a study of stabilization and the development of the final or climax community.

The structure and units of vegetation are treated at length and the views of various ecologists upon these subjects summarized. One of the most interesting, as perhaps most valuable, parts of the book is the attempt of the author to focus attention more sharply than has ever been done before upon the fact that plant communities may and should be

classified by means of seral units as well as by climax units. Both methods have been used by various investigators rather indiscriminately, or at least no particular model (if there be such) has been followed consistently. Clements rightly emphasizes the desirability of working out and adopting a set of terms to cover these two concepts of vegetation and he goes so far as to propose terms by means of which the various climax and seral features of the plant formation may be described. The reviewer is aware of the advantages and disadvantages of the various systems which have been proposed in the past and we must confess that this latest proposal is perhaps still far from the ideal, and yet it represents an advance, it marks progress. At least it serves to focus the attention upon the dynamic phases of vegetation as apart from the static. The author may be criticized for the introduction of new terms in this connection, but new concepts or relations may be expressed only by appropriate words. Scientific men should not be confounded by the introduction of an occasional new term.

The *climax* units which Clements proposes are: *associations*, climax communities which associated regionally constitute the formation; *consociations*, the units of the association, characterized by a single dominant species; *societies*, communities within an association or consociation controlled by one or more subdominant species; and *clans* or aggregations of secondary species within either of the above subdivisions. The clan is quite local and often not sharply delimited from the society.

Seral units are analogous to climax units or communities throughout the course of succession. These units are proposed in order to point out sharply the distinctions between the developmental or dynamic and climax or static phases of vegetation. The *associes* is the developmental equivalent of the association, differing from the latter only in its transient nature. The *consocies* corresponds to the consociation in the same manner that associes corresponds to association. "The consocies is a seral community marked by the striking or complete dominance of one species, belonging, of course, to the life-form typical of that stage of development." The *socies* is likewise the developmental equivalent of the society. The *colony* is an *initial* community of two or more species. Colonies resemble clans in their limited size and absence of clearly defined relation to the habitat. From their appearance in bare areas colonies are nearly always sharply delimited. The invasion of weeds frequently follows the colony type of grouping. The *family* is a group of individuals belonging to one species. Because of this nature families are quite rare in general, but they are common in bare areas and in the initial stages of a succession. This attempt to work out a classification of vegetation types founded upon the developmental basis should appeal to all broad-minded students of plant ecology.

Another valuable portion of Clements's book is the part devoted to the climax formations of North America as summarized from the available literature.

Successional studies in Eurasia are also abstracted.

An extended portion of the monograph is devoted to a discussion of "past climates and climaxes" or to the succession of vegetation in remote times as revealed in the geological record. "The operation of succession was essentially the same during the geological past that it is to-day: from the nature of their vegetation forms, the record deals largely with the ultimate stages of such successions. It is evident that geological succession is but a larger expression of the same phenomenon, dealing with infinitely greater periods of time, and produced by physical changes of such intensity as to give each geological period its peculiar stamp. If, however, the geological record were sufficiently complete, we should find unquestionably that these great successions merely represent the stable termini of many series of smaller changes, such as are found everywhere in recent or existing vegetation. . . . In short, the development and structure of past vegetation can be understood only in consequence of the investigation of existing vegetation."

The investigations of Douglas on "Weather Cycles in the Growth of Big Trees" and "A Method of Estimating Rainfall by the Growth of Trees," of Huntington on the climatic factor, and of Humphreys on the relation of volcanic dust to climatic changes, etc., appear to have been the chief inspiration and sources for this particular portion of the monograph.

This is a very new field for the modern student of plant succession. The author states that: "The interpretations of past vegetations rests upon two basic assumptions. The first is that the operation of climatic and topographic forces in moulding plant life has been essentially the same throughout the various geological periods. This is a direct corollary of the conclusions of Lyell as to geology, and of Huntington, Humphreys and others as to climatology. The second assumption is the one already quoted, namely, that the operation of succession as the developmental process in vegetation has been essentially uniform throughout the whole course of the geosere. From these two assumptions naturally follows a third to the effect that the responses of animals and man to climate and to vegetation, both as individuals and in groups, have remained more or less identical throughout geological time. As a consequence of Darwin's work, this has long been accepted for the individual, but as to the community it still awaits detailed confirmation by the new methods of zoecology. Further, if all these be accepted as necessary working hypotheses, it is evident that what is true of the parts must be true of the whole plexus of geological causes and biological responses in the past."

The attempt is then made to trace the successions through the various geological eras with their shifting climates and climaxes. But here again the details are so numerous and so many biological principles are involved that only first-hand examination of these chapters can give the reader an adequate conception of the matter handled in this way. In passing it is interesting to note that Clements has used vegetation rather than animal life as the basis for the recognition of eras of the geological record, somewhat after the fashion of Saporta (1881). Thus we read: Eophytic, Paleophytic, Mesophytic, Cenophytic.

These latter chapters should be particularly suggestive and stimulating to the animal ecologist and the paleo-ecologist as well as to others with an interest in the phenomena of living thing of past ages.

The bibliography of nearly a thousand titles, the most of which have been abstracted or noted somewhere in the text, is still another valuable part of the book. This is probably the most nearly complete collection of titles on succession and related phenomena available.

It may be said, after securing a bird's-eye view of the book as a whole, that Clements's monograph presents an invaluable summary of our knowledge of plant succession and that it must become at once the indispensable reference and guide for the student of vegetative cycles in all parts of the world.

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SPECIAL ARTICLES

RECENT INVESTIGATIONS OF TRACTIVE RESISTANCES TO MOTOR TRUCKS ON ROADS AND PAVEMENTS

An experimental investigation was carried on in the research division of the electrical engineering department, at the Massachusetts Institute of Technology, during the year 1915, under a fund contributed for researches on motor trucks, for the purpose of determining the tractive resistance of a motor delivery wagon with four wheels and solid rubber tires on various level urban roads and pavements. The complete report on this research was published in the *Proceedings of the American Institute of Electrical Engineers,* June, 1916.

By "tractive resistance" is meant the horizontal force necessary to apply to the truck in order to keep it at a constant speed in still air after deducting axle frictions and internal-mechanism losses. It is, therefore, the reactive force offered by the truck, assumed

internally frictionless, in overcoming the road, tire and still-air resistances on a level surface. It may be expressed either in pounds weight per short ton of total moving mass, or in kilograms per metric ton, or in per cent. equivalent grade. Thus a 1 per cent. equivalent grade tractive resistance means that a car without axle friction or other internal mechanism losses would require to be pulled on a level road at a constant stated speed a force of 20 pounds per short ton of 2,000 pounds, in order to overcome the resistance of the tires, road-bed and still-air displacement. This force would obviously serve to propel the same vehicle up a 1 per cent. grade in the absence of tire, road-bed, still-air and internal frictions. At a given speed, therefore, this tractive resistance depends upon the wheel, the tire, and the road, and also on the air-displacement resistance of the truck.

The truck tested was a 1,000-lb. (450 kg.) electrically-propelled delivery wagon equipped with single solid rubber tires, one on each of the four wheels—the tire rating being 36 in. by 2½ in. (915 mm. by 63.5 mm.). The tests were made by running the car at, as nearly as possible, constant measured speed, in alternate directions, over selected lengths of standard roads in and near Boston. From the observed storage-battery outputs during these runs, the corresponding tractive resistances were evaluated after correcting for all losses internal to the truck mechanism, wind losses, grade and incidental accelerations. The internal losses of the truck mechanism from battery terminals to wheel spokes were determined from laboratory tests with the car raised from the ground on jacks, and by driving tested dynamos from the rear wheels.

The following is a summary of the results obtained as applying to urban roads with this truck between the speed limits of from 13 to 25 km. per hour (8 to 15.5 miles per hour).

1. The over-all efficiency of the test-truck mechanism between battery terminals and rear-wheel treads reached a maximum value of about 78 per cent., under the most favorable conditions.

2. The mechanical efficiency of transmission from motor shaft to rear-wheel treads, for the truck tested, shaft-driven through a single-reduction worm gear, was found as high as 90 per cent.

3. Under the conditions of these tests, the tractive resistance on level roads, in the absence of wind, is composed of (*a*) displacement resistance, (*b*) impact resistance and (*c*) air resistance.

By "displacement resistance" is meant that portion of the tractive resistance which depends on the lack of resilience of a smooth road surface and of the wheel-tire material; *i. e.*, on the energy losses due to inelastic displacement of tire and road-surface materials.

By "impact resistance" is meant that portion of the tractive resistance which depends on the lack of smoothness of the road surface, and which is due to the impacts given to the moving vehicle by the irregularities of the road.

By "air resistance" is meant that portion of the tractive resistance due to air pressure on the moving vehicle necessary to displace the air in the absence of wind.

4. The displacement resistance varied from 0.85 per cent. equivalent grade, for a hard smooth asphalt or bituminous concrete, to 1.6 per cent. for a very soft tar-macadam road, and was practically constant, for all speeds considered, on any given road.

5. The impact resistance increases with the velocity, with the total weight of vehicle, and with increasing road-surface roughness. In these tests, the impact resistance of good asphalt or bithulithic or other smooth pavement, was practically negligible, and reached its highest values (about 1.5 per cent. equivalent grade at a speed of 20 km. per hr. (12.4 miles per hr.) on granite-block roads with sand filled joints, and on badly worn macadam pavements. The rate of increase of impact resistance with speed was most marked on the roughest roads.

6. At the vehicle speed of 20 km. (12.4 miles) per hour, the air resistance for the vehicle tested, assumed to be dependent only on the speed, was roughly 0.11 per cent. equivalent grade; *i. e.*, from 4 per cent. of the high-

est, to 12.5 per cent. of the lowest, total tractive resistance.

7. The following urban pavements are enumerated in the order of their desirability for vehicle operation from the point of view of tractive resistance at 20 km. (12.4 miles) per hr., as found in this investigation. (1) asphalt, (2) wood block, (3) hard smooth macadam, (4) brick block, (5) granite block with cement-filled joints, (6) cinder, (7) gravel, (8) granite block with sand-filled joints.

8. The equivalent grade at 20 km. (12.4 miles) per hr. of a badly worn city macadam road, was found to be nearly three times as great as that of the best asphalt road tested. This means, at this speed, a consumption of energy at wheel treads, of nearly three times as much on level poor macadam roads as on good level asphalt roads.

9. Increasing the gross weight of the vehicle by 12 per cent. through load, was found to have no effect on tractive resistance within the observed speed limits for smooth roads in good condition; but on rough roads, a distinct increase in tractive resistance with this extra weight was observed.

10. The presence of a layer of dust, say one cm. thick, on a fair macadam road, was found to increase the equivalent grade of tractive resistance, at a speed of 20 miles (12.4 km.) per hr., from 1.17 to 1.32 per cent.

11. A freshly tarred and therefore very soft tar-macadam road was found to have an increased tractive resistance equivalent grade, at substantially all tested speeds, of about 0.5 per cent. The tires in this case sank about 0.8 inch (2 cm.) into the road-bed, the gross car weight being 2,140 kg. (4,710 lb.).

12. The total range of tractive resistance equivalent grade covered in the tests, was from 0.93 per cent. on the best asphalt road, at lowest speed, to 2.7 per cent. on the worst macadam road, at nearly the highest speed.

13. The results indicate, as has already been pointed out by other observers, the importance of constructing and maintaining smooth, hard and clean roads, from the point of view of tractive resistance. Low tractive resistance means small gasoline consumption for gasoline trucks, and a reduced electricity expense or greater daily mileage with electric trucks.

14. Other problems which are of practical importance to vehicle designers and operators, and which require further investigation are the following:

(*a*) Tractive resistances on country roads.

(*b*) Tractive resistances to vehicles with different wheel tires.

(*c*) Tractive resistances of urban roads at low speeds from 0 to 10 miles per hour (16 km. per hr.).

(*d*) Tractive resistances at speeds higher than 15 miles per hour (24 km. per hr.).

(*e*) Tractive resistances for high-capacity trucks.

15. The results of the tests here reported have been found to be in substantial agreement with those obtained by other observers employing somewhat different methods; but the analysis of tractive resistance into its components here presented appears to be new, and is recommended for use in similar investigations or tests.

16. The writers are indebted to Mr. Thomas A. Edison and also to the Gould Storage Battery Co. for funds by which the research was made possible.

A. E. Kennelly,
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Massachusetts Institute of Technology,
Cambridge, Mass.

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 563d meeting of the society was held in the assembly hall of the Cosmos Club, Saturday, January 13, 1917, called to order by President Hay at 8 P.M., with 45 persons in attendance.

On recommendation of the council Dr George W. Field, Biological Survey, was elected to membership.

President Hay announced the membership of the Publication Committee; C. W. Richmond, J. H. Riley, Ned Dearborn, W. L. McAtee; and the membership of the committee on communications: Wm. Palmer, Alex. Wetmore, R. E. Coker, L. O. Howard, A. S. Hitchcock.

Under the heading of brief notes W. L. McAtee and Alex. Wetmore called attention to the presence

of white-winged crossbills in the vicinity of Washington, constituting the second authentic record of this species in the District fauna. The first specimen was seen by Mr. McAtee on December 10, 1916, in a flock of American crossbills. Later other specimens were seen on December 24, 27 and 30, as single birds and also in flocks, Mr. Wetmore having seen as many as forty birds together.

In contrast to this unusual northern visitor Mr. McAtee mentioned the lingering of summer birds, having noted a Cape May warbler on December 6, and a bluegray gnatcatcher about two weeks ago. He also mentioned having found a box turtle out and active on January 7, 1917.

Mr. E. A. Goldman mentioned the reported occurrence of Hudsonian chickadees in the vicinity of New York City and Boston.

Mr. A. S. Hitchcock called attention to the unusual precautions that were being taken in the care of the herbarium of the British Museum.

The regular program was as follows:

Some European Experiences with Entomologists: L. O. Howard.

Under the above title Dr. Howard read three short papers, entitled (a) "Rennes and René Oberthür," (b) "An Entomological Trip to the Crimea," and (c) "The Episode of Theophile Gautier," all illustrated with lantern slides. In the first he described the personality of René Oberthür, one of the great amateur collectors of insects in Europe, and his beautiful place at Rennes where he has a private museum, an extraordinary arboretum, and one of the largest collections of orchids in existence. He spoke at some length of the very important voluntary assistance which M. Oberthür had given the Bureau of Entomology in the collection and importation of the parasites of the gipsy moth and the brown-tailed moth from Europe into the United States, and gave an account of an automobile journey through Brittany and Normandy in the summer of 1909, on which he was accompanied by M. Oberthür and by Paul Marchal, of the Station Entomologique de Paris.

In the second paper he described a journey from Budapest through Lemburg to Kiew in 1907, the establishment of an experimental station at Kiew under the direction of Professor Waldemar Pospielow, of the University of Kiew, of the journey thence to Sebastopol, Bachtisserai and Simferopol; of the regional museum at the latter place under the charge of Professor Sigismond Mokshetsky, and of the excellent work in economic entomology done by Professor Mokshetsky in the Crimea. He also mentioned the old palace of the Khan of the Crimea at Bachtisserai and the marine zoological laboratory at Sebastopol.

In the concluding episode he described his personal experiences in 1910 and 1912 with Theophile Gautier, one of the most successful rose-growers of France, at Angiers, a man of the simplest appearance and habits but of the highest standing in horticultural circles and an *Officier* of the order of *Mérite Agricole.*

Recent Additions to the List of North American Birds: H. C. Oberholser.

Dr. Oberholser said that the period from 1910 to 1916, inclusive, was one of great ornithological activity. During this period fully 125 species and subspecies were added to the list of birds known from North America. Most of these additions resulted from the description of new subspecies or the revival of hitherto unrecognized forms, which together amount to over 100, among the most interesting being five new subspecies from Newfoundland. Two distinct species were described from North America during this time: *Æstrelata cahow* from the Bermuda Islands, and a remarkable new gull, allied to *Larus californicus,* called *Larus thayeri,* from Ellesmere Land. Also a number of extra limital forms were for the first time detected within our boundaries, among the most notable of which might be mentioned *Puffinus carneipes* taken in California; *Totanus totanus* from Greenland; *Calliope calliope camtschatkensis* and *Hypocentor rusticus,* both from Kiska Island, Alaska; *Nyroca ferina, Marila fuligula, Clangula clangula clangula, Cryptoglaux funerea funerea, Coccothaustes coccothaustes japonicus,* and *Fringilla montifringilla,* all from the Pribilof Islands; *Pœcilonetta bahamensis* from Florida; *Petrochelidon fulva pallida* from Texas; and *Tyrannus melancholocus satrapa* from Maine.

The Fossil Seacow of Maryland: Wm. Palmer.

Mr Palmer exhibited the fifth thoracic neural arch of a sirenian which was shown to be unlike that of the manatee and to agree absolutely, except in size, with a similar bone of Steller's seacow (*Hydrodamalis*) from Bering Sea. The specimen was found, freshly fallen, under a cliff of the Calvert Miocene on the western shore of Maryland. It was suggested that the species was living during the period following the first erosion of the Cretaceous and the deposition of the Eocene as all the specimens so far found in the Miocene were clearly redeposits from an earlier age.

M. W. Lyon, Jr.,
Recording Secretary

SCIENCE

FRIDAY, APRIL 13, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

FOOD VALUES[1]

SUSPICION often attaches the value of the recommendations of the laboratory experimentalist and this reaction may be more or less well founded. In a delightful address to medical students Simon Flexner recently warned his audience not to think of coming to him for medical treatment. A general of the United States Army told me only yesterday that a professor might be able to hold his students to a complete examination upon the subject of the Thirty Years' War, mark each student in accordance with his deserts, and yet the professor might be of the type who would get lost in his own back yard. Such a danger besets the path of him who would speak upon the subject assigned to me to-night. It appears, however, that scientific knowledge of nutrition has sufficiently advanced to make it of some practical service to the people. Dr. Mendel and I would not be speaking together here to-night did we not feel that we had messages to deliver, and yet it must be evident that in this country such messages are merely personal opinions susceptible to challenge and that they carry little weight with the community.

Many are familiar with the report of the Eltzbacher Commission which concerned itself with the food situation in Germany at the outbreak of the war. The commission was intended to bridge the chasm between helpless specialization and superficial versatility. Fifteen of the foremost scientific men of the land approved the report. Mistakes were made, such as overestimates of

[1] Address delivered before the Home Economics Association and the Society of Chemical Industry, March 23, 1917.

the food available and underestimates of the food required by women who took up the work of men and underestimates of the food required during adolescence. The American investigations of Du Bois and of Gephart, which demonstrated the increased food requirement of growing boys, were not there available, and the increase in the rations for such children was not made in Germany or in Belgium until October, 1916.

It was unfortunate that the carrying out of the recommendations of the Eltzbacher Commission was left to politicians, farmers and middlemen. The scientists of the country were not represented and the result was chaos.

Dr. Alonzo E. Taylor has recently published a very complete account regarding the food supply of blockaded Germany. He points out the fact that, in spite of all exhortations and of all regulations, it is the farmer's wife who gets the egg.

In a pamphlet published in June, 1916, Rubner described how the prices of foodstuffs had been enormously increased by the middlemen. The price of meat and of eggs doubled in a month and this happened, of course, without any regard to the cost of production. Rubner frankly states that the lust for gain produced conditions which had no regard to the political conditions of the country and that the efforts to control prices since August, 1914, had been without results. Bread in Germany was rationed and only half the quantity usually taken in peace time was allotted. This represented the omission of twenty per cent. of the usual ration. Meat and milk were scarce and expensive and in some cities were unobtainable. Green vegetables, as a source of nourishment, were as expensive as meat, and potatoes were also scarce. Conditions were such that in some cities the inhabitants received only a third of the usual food supply. The farmer continued to live as had been his wont, whereas the urban dweller suffered. Families dependent upon the earnings of a physician, for example, suffered acutely not only through the withdrawal of the income of the man who was in the army, but also from the high food prices. The hand of the food dictator was restrained on account of a thousand obstacles put in his way through faults inherent in human character.

It may appear a contradiction of terms to hear in the same breath that there is a shortage of food in Germany and yet that the people are not starving. This is due to the fact that in extreme cases of undernutrition it is possible to reduce the requirement of food to only forty per cent. of its former level. The under-nourished and emaciated may, therefore, live on much less food than those who are well fed and are up to normal weight.

The popular idea that "most people eat too much," which one hears expressed in common table talk, is not true. People who do not change in weight eat just enough to maintain the condition in which they have established themselves. They may, however, lose their surplus fatty tissue by restricting their diet.

Another popular formula which has been elevated to the height of dogma is, "it is not what you eat but what you digest that is of importance." Since the normal person very completely digests all the common food-stuffs, there is little to concern one in this saying. Repeated ignorantly from mouth to mouth, such a remark, even though true, comes to cloak many dietetic absurdities.

An English scientific commission, of which Gowland Hopkins, Noël Paton and others were members, published on February 1 of this year a report of British food conditions. They found that during the five years preceding the war the average annual consumption of food in Great Britain amounted to the equivalent of 51

million million calories, or 3,091 calories per person per day. They assume that the food requirement of 100 men, women and children is the same as that of 77 "men." Therefore each "man" received 4,000 calories daily in a diet containing 113 grams of protein, 571 grams of carbohydrate and 130 grams of fat.

The distribution of this food fuel for the British nation appears in the following table:

TABLE SHOWING ANNUAL YIELD OF CALORIES OF THE CHIEF CLASSES OF FOOD-STUFFS IN THE YEARS 1909–13 IN GREAT BRITAIN

	Energy Value in Millions of Calories	Percentage
Cereals	17,712,000	34.7
Meat	8,890,000	17.4
Dairy produce (including lard and margarin) ...	8,253,000	16.2
Sugar (including cocoa and chocolate)	6,633,000	13.0
Vegetables	4,812,000	9.4
Cottage and farm products	2,655,000	5.2
Fruit	1,077,000	2.1
Fish	531,000	1.0
Poultry, eggs, game and rabbits	461,000	0.9
	51,024,000	99.9

The commission points out that 30.8 per cent. of the energy in the diet of the people is derived from wheat. Meat yielded 17.4 per cent.; sugar, 13. The three food-stuffs together yielded 61 per cent. of the total energy in the diet. Dairy products and vegetables furnished 25 per cent., and all the rest of the food 13.4 per cent. of the total energy.

The commission emphasizes the fact that if the workers do not get enough to eat they can not do the same amount of work; that a man may by grit and pluck work hard on a low ration, but he is living on himself and soon his work will fail. Stress is laid upon the fact that "in buying food the laboring population is buying energy" and that "a slight reduction of food below the necessary amount causes a large diminution in the working efficiency of the individual." Thus, the troops in the field receive 4,300 to 4,600 calories because they must accomplish hard work and are much exposed to cold. Dr. Murlin has calculated that the "garrison ration" of the United States Army contains 4,400 calories, while the "field ration" contains only 3,800.

The food controller of Great Britain on February 1, 1917, asked the population to voluntarily restrict the consumption of flour, meat and sugar to a measured quantity of these materials per week. This ration would yield about 1,750 calories per "man" daily and leave the individual to supply an equal quantity from other available sources. The individual allotment for each individual each week is 3 lbs. flour, 2½ lbs. meat and ¾ lb. of sugar. The distribution per "man" appears in the following table:

RATION PER "MAN," ADVISED BY BRITISH FOOD CONTROLLER, FEBRUARY 1, 1917

Food per Week, Lbs.	Food per Day					
	Oz.	Grams	Calories	Protein Grams	Carbohydrate Grams	Fat Grams
Flour, 4.	9.1	258	939	29	194	3
Meat, 3½.....	7.6	216	540	41		40
Sugar, 1.	2.3	65	267		65	
Total..........			1,746	70	259	43

This allotment ensures a safe protein ration.

Valuable data are given for the relative cost of production of milk and various meats. Thus, 2.9 pounds of "starch equivalent" in the fodder will produce milk containing 1,000 calories. Three pounds of starch equivalent are required to produce 1,000 calories of pig meat and 4.7 pounds and 9 pounds, respectively, to produce 1,000 calories in veal and in beef. Dairy products, pig meat and veal are therefore far cheaper sources of protein than is beef. The increased production of milk is highly desirable, but it is pointed out that changes in the condition of agriculture take time.

England has already restricted the area of land which can be devoted to promotion of the beer industry. The commission states that repeated experience shows that alcohol is unfavorable to the marching powers of troops.

It is of especial significance that in the stress of war the British state recognizes that the laborer, in buying food for himself, is in the main buying energy to support himself as a machine. It seems to be the crying need of the times that those who purchase food shall be able to know what food is, what they are getting for their money, and whether in asking for bread they are in reality receiving stones.

Murlin was the first to suggest that the government compel manufacturers to place upon each can, or package, or barrel of food sold, the caloric content available as food fuel. Only in this manner can the housewife be informed regarding the relative nutritive value of the beautiful packages she sees in the grocer's window. In my judgment the time is ripe for this procedure. One knows, furthermore, that different proteins have different values, and to this knowledge Dr. Mendel has contributed not a little. I wish to repeat what I said before the Washington Academy of Sciences a year ago:

The proteins of meat, fish, eggs and milk will replace body protein part for part. Such proteins may be classified as proteins of Grade *A*. Gelatin has practically no power to replace body protein and should be classified as protein of Grade *D*. Wheat contains a mixture of proteins of Grades *A* and *D* in which those of Grade *A* predominate, so that wheat may be classified as containing protein of Grade *B*, whereas from analogous reasoning corn may be said to contain protein of Grade *C*.

An ordinary dietary with a liberal allowance of protein contains 15 per cent. of its calories in that form. A can containing 15 per cent. of its calories in protein should have a star placed with the letter determinative of the grade of protein. For example the label on a can of corn should read, "This can contains x calories, of which y per cent. are in protein of Grade *C*." A further desirable statement would be as to whether the food-stuff sold contained the natural mineral constituents from the organic source from which it was derived.

I have repeatedly emphasized the desirability that the government should give this information with regard to all food-stuffs sold in packages. The determination of the heat of combustion of a dried sample of food takes fifteen minutes. Probably three hours would suffice to make a complete analysis by a government expert. The manufacturer should send his sample can to the Bureau of Chemistry at Washington, declaring that to be his standard and requesting information regarding his label. He should pay for this analysis as a patentee pays for his patent. If at any time the government should find the manufacturer selling on the market a material of different character than the standard deposited with the government, the manufacturer should be heavily fined.

It seems that these doctrines might be powerfully forwarded at the present time. I believe that they are sound doctrines, potent for accomplishing immeasurable good. It has passed unnoticed that during the current year the cereal products, such as wheat flour, oatmeal, hominy and rice, are all selling on the basis of the same value per thousand calories. The world's necessity has caused this.

A year ago I prepared a table representing the cost of 2,500 calories in various foods and a comparison of the cost of these to-day is presented in the following table:

WEIGHTS OF VARIOUS FOODS NECESSARY TO FURNISH 2,500 CALORIES AND COST AT 91ST STREET AND SECOND AVENUE, NEW YORK CITY

(A man of sedentary occupation requires 2,500 calories daily.)

Articles	Weight		Cost	
	Lbs.	Oz.	1916	1917
Cornmeal	1	8	\$0.04½	\$0.08
Hominy	1	8	0.04½	0.08
Oatmeal	1	5½	0.05¼	0.07
Flour	1	8	0.06	0.09
Sugar	1	5½	0.06¾	0.09
Rice	1	8½	0.07¼	0.08
Day-old bread	2	1	0.08¼	0.09
Beans	1	9	0.14	0.21
Potatoes	8	1	0.16	0.40
Apples	11	5	0.38	0.57
25,000 calories	31	11	\$1.11	1.76

Experiments from my laboratory with R. J. Anderson have recently demonstrated that the same amount of energy is used by a dog in running three miles in an hour whether the work be done eighteen hours after food ingestion, that is to say, after the food has been digested and absorbed, or whether it is done immediately after the ingestion of glucose in large quantity. If, however, meat in large quantity is given, the extra heat production following upon work amounts not only to the quantity demanded for the work accomplished, but also there is added the considerable quantity of heat produced by the stimulation of metabolism through the substances formed in the breakdown of protein. Meat, therefore, is not the great provider of energy for the accomplishment of mechanical work, but rather carbohydrate food, such as bread, macaroni and rice, all of which are found in the dinner pail of the laborer. These furnish fuel without waste, fuel for accomplishment of the day's work. Fat undoubtedly behaves in a similar fashion, though experiments to demonstrate this have not yet been instituted. Meat in quantity is not necessary for the maintenance of vigorous muscular power. It is gratifying to the palate, but Chittenden has been justified in his belief that small quantities only are essential to repair the wear and tear on the protein content of the organism.

During the recent rise in the cost of foodstuffs I compiled, at the request of an officer of the State Board of Health, the following low-cost meatless dietary of high caloric value designed for a family of five persons, the father at work and the mother doing household work. Potatoes, with their valuable alkaline salts, had to be excluded from the diet because of their prohibitive price. The diets were based on menus given in the excellent book, "Feeding the Family," recently published by Mrs. Mary Swartz Rose. The cost amounted to $1.16 daily for 14,400 calories, or eight cents per thousand calories, which is not a high price.

LOW-COST MEATLESS DIETARY OF HIGH EFFICIENCY VALUE FOR A FAMILY OF FIVE PERSONS, FATHER AT WORK AND MOTHER DOING HOUSEHOLD WORK

Essentials.—Do not buy meat until you have bought *three quarts of milk a day.* Milk contains valuable tissue-building food, valuable salts and invaluable *vitamines* which help to sound health.

If you buy bread remember that day-old bread is much cheaper than freshly baked bread and is just as good a food.

The menus may be arranged as follows:

Breakfast

Corn meal mush,[2] fried (+ milk for children and corn syrup for adults).
Bread (or toast).
Oleomargarin.
Coffee (for adults).
Stewed prunes.
Orange juice for baby.

Luncheon or Supper

Pork and beans[3] (bean soup for young children).
Bread.
Oleomargarin.
Tea with milk and sugar for adults.
Milk for youngest children.
Cereal coffee or cocoa for older children.
Sliced bananas with sugar.[4]

Dinner

Lentil soup.[5]
Boiled rice.[6]
Tomato catsup.

[2] Or oatmeal, or hominy, or farina, or buckwheat cakes.

[3] Or creamed dried beef on toast.

[4] Or stewed dried peaches or the bananas may be boiled in their skins.

[5] Or potato, or bean, or pea soup.

[6] Or spaghetti, or macaroni (with cheese) or baked split peas with bacon.

Bread.
Oleomargarin.
Tea for adults.
Milk for youngest child.
Dried apple pie with cheese for adults.
Dried apple sauce for others.

THE APPROXIMATE COST PER DAY AND THE NUTRITIVE VALUES IN CALORIES APPEAR BELOW

	Amount	Calories	Cost in Cents
Coffee	2¼ ounces		3
Tea	½ ounce		2
Milk	3 quarts	1,800	27
Bread	2 pounds	2,500	9
Cereal	¼ pound	800	4
Oleomargarin	¾ "	2,500	19
Corn-syrup	¼ "	650	2
Sugar	¼ "	450	2
Rice or macaroni	1 "	1,600	8
Dry navy beans	10 ounces	1,000	7
Fat pork	6¼ "	1,000	6
Dry fruit (prunes)	1 pound	325	12
Flour, lard, etc., for pie or other extras		1,800	15
		14,425	116

As cheaper meats, pork sausages, braised chuck rib of beef, salt cod or herring may be added if finances allow.

This is one method of giving scientific advice. I believe that it may be also possible to arrange in convenient locations throughout a town grocery stores with milk stations adjoining, and that here baskets may be exchanged daily, an empty one for a full one, the baskets varying somewhat from day to day but containing 5,000, 10,000 or 15,000 calories of basic food fuels.

We are told that Joseph fed the Egyptians with grain stored during seven years of plenty. Whether the municipality of the future will purchase wheat and ration bread in quantities sufficient for its inhabitants is a serious question. The railroads of the country receive three thousand million dollars for the service which they render. They must pay high wages and must not increase their charges for what they have to sell. The food problem involves a national expenditure of at least six thousand million dollars a year. The food problem is a national problem which more directly affects living expenses of the very poor than any other problem. The railroads do not enhance the cost of food more than four per cent. of its total cost. The cost of food is, as has been shown, not always dependent upon the cost of production. The cost of gas is regulated by the state and yet the gas companies pay dividends. The cost of bread may some day be lowered by reducing the number of middlemen and by some sort of state control. It is important, also, to find some means to increase the supply of milk. This might be encouraged by a tax on steers of ten dollars each, payable every six months, a procedure which would enhance the price of beef but would induce the farmers to feed their fodder to milch cows or to pigs.

This has brought me to the point where I started—that the professor may get lost in his own back yard. However, it does seem to me that this is a proper time for an American commission to consider these subjects and to report to our government what elemental advice the commission might agree to give. Surely, some consensus of opinion might be arrived at by a commission meeting in Chicago and composed of Mendel, Taylor, McCollum, Folin, Levene, Sherman, Armsby, Langworthy and Benedict. This would mean the submergence of the individual for the instant, in an attempt at welfare work for the nation at large. It would be an experiment worth trying.

Graham Lusk

New York City

GRAVITY AND ISOSTASY

There has recently been issued from the government printing office a volume of 196 quarto pages, known as Special Publication No. 40 of the Coast and Geodetic Survey, bearing the title, "Investigations of Gravity and Isostasy," written by Mr. William Bowie.

This volume is so important to geodesists and geologists that the undersigned believes that its appearance warrants more attention than merely a review of the ordinary kind and length. Hence the present article is presented. The volume is of especial interest because it is based on many more observations of gravity than were formerly available in the Coast and Geodetic Survey, and because the discussion of the data is much more searching and complete than anything heretofore published.

The last preceding publication on this subject from the Coast and Geodetic Survey was issued in 1912.[1] The conclusions in that publication were based almost entirely upon the 124 gravity stations in the United States and 10 in Alaska. In the present publication conclusions are based primarily upon observations at 219 stations in the United States and are tested by observations at 42 stations in Canada, 73 in India and 40 in other parts of the world—374 stations in all. This increase in the number of stations and of the area covered by them is important because the reliability of the conclusions drawn depends upon the completeness with which effects peculiar to a given station or a locality are eliminated, and upon the extent to which supposed general laws are found to be confirmed by the evidence from widely separated areas.

Within the past four years there has been one radical change in the relative method of observing gravity in the United States, with the half-second pendulums, the standard method of the Coast and Geodetic Survey. Formerly each gravity observer carried a transit instrument with him and determined the errors of his chronometers on each clear night. Now he determines the chronometer errors by the time signals sent out from the Naval Observatory at Washington, special studies having shown that these signals are of ample accuracy for the purpose. The time and expense necessary for securing a gravity determination at a station is thus materially reduced, and the rapid increase in the number of gravity stations which is the prime essential of future progress is facilitated.

The most severe test which may be applied to a theory, or a supposed understanding of a group of facts, is a test by prediction. Such a test has been applied by the writer recently to the Coast and Geodetic Survey theories as to the intensity of gravity, including the method there used for computing the effects of topography and isostatic compensation. In the 1912 gravity publication already referred to (Special Publication No. 12) there is a map of the "lines of equal anomaly for the new method of reduction." This map, based upon 124 gravity stations in the United States, may be used in combination with computations for which the methods have been fully published, to predict the intensity of gravity at any point in the United States. Such predictions, for 95 gravity stations, based on the 1912 map have been made by the writer,[2] and compared with the observations made after 1912 at those stations. The difference of prediction and observation was less than .02 dyne (1/49,000 part) in 54 out of the 95 cases. Such a prediction may be made in about three days by an expert computer in Washington at a cost to the government of about $25. On the other hand if a physicist undertakes to determine gravity in his own laboratory by an absolute method, past experience shows that after many weeks of time and an expenditure, including salaries, of many hundreds of dollars, it would be an even chance whether his final result would be within .03 dyne of the truth. To reduce the probable error sufficiently to be equal to that of the prediction which may be made in Washington in three days by a computer would require the equivalent of months of time by an expert physicist.

Still more accurate predictions are certainly now possible by the use of the 1917 map, based on 261 stations in the United States and Canada, which is necessarily a decided improvement for prediction purposes over the

[1] "Effect of Topography and Isostatic Compensation upon the Intensity of Gravity," by William Bowie, Special Publication No. 12.

[2] The writer took advantage in making these predictions of detailed computations which had been made at Washington of the effects of topography and isostatic compensation at these stations.

1912 map, which was based on 124 stations only.

Mr. Bowie's general conclusion in regard to isostasy in the United States is as follows:

The group of publications of the Coast and Geodetic Survey dealing with deflections and gravity values shows that isostasy exists in a form nearly perfect in the United States as a whole, also that there is nearly perfect isostasy in areas which form comparatively small percentages of the area of the entire country.

The abundant evidence presented supports this conclusion fully. It is important to note that a conclusion of this general character was originally based, not much more than ten years ago, on a small fraction of the evidence now available and that although the amount of evidence has increased greatly, and the evidence has been studied much more intensely, the general conclusion has simply been confirmed abundantly and repeatedly—being modified only in details.

The largest anomaly noted in the United states to date, at Seattle, Washington, —.093 dyne, was recognized as a very large anomaly as early as 1910, when only 89 gravity stations were available in the United States. Since that time with an increase in the number of stations to 219 it is interesting to note that no other anomaly larger than .059 dyne has been found in the United States. So also when the study was extended to Canada (42 stations) the largest anomaly there discovered was only —.045, and in India (73 stations), the largest discovered was —.078 dyne. In other parts of the world only four anomalies have been found which are larger than that at Seattle. Each of these four is on an oceanic island or near a steep continental shore. The anomalies referred to in this paragraph are the residuals after topography and isostatic compensation have been taken into account in the computation. The extension of the computation of isostasy, in a form based upon a few stations in a restricted area, to other stations and to other areas, shows an agreement with the facts which is substantially as close at the new stations and in the extended area as at the original stations in the original area.

Two additional gravity stations having now been occupied near Seattle, it is evident that this largest anomaly in the United States, —.093 dyne, is a comparatively local matter, not a characteristic of a large area. The writer understands that additional unpublished observations emphasize this statement still further.

It is evidently desirable to supplement studies of gravity made by means of stations scattered widely, and somewhat uniformly, over a large area such as the United States, by intensive studies of selected small areas in which a large number of stations are concentrated. The beginning of one such study has been made in the vicinity of Washington, D. C., where observations have been made at seven stations within twenty miles of the capitol.

No discernible general relation is found between areas of recent erosion or recent deposition, on the one hand, and areas of negative anomaly or of positive anomaly, respectively, on the other hand.

The strength of the proof of the validity of the method of computation used in the Coast and Geodetic Survey for taking into account the effects of topography and isostatic compensation upon the intensity of gravity depends in part upon the extent to which the remaining anomalies seem to be independent of the topography around the stations. Hence special intensive studies upon this point have been made repeatedly at the survey. The latest evidence, as set forth in this publication, shows the remaining anomalies to be almost, if not quite, independent of the topography. There is a slight apparent tendency for coast stations to have negative anomalies. But the indications are that this tendency is due to the prevalence of Cenozoic formations along the Atlantic and Gulf Coasts of the United States, not to the nearness of the stations to the coast.

No other method of computation which has been published gives anomalies which are thus independent of the topography.

There is found to be a decided tendency for gravity stations located on Cenozoic formations in the United States and in India to

have negative anomalies, that is, for the intensity of gravity to be below normal at these stations. On the other hand, for stations in the United States on pre-Cambrian formations there is a decided tendency toward positive anomalies, that is, for gravity to be in excess. The evidence of a tendency toward defective gravity in regions in which the surface geologic formations are comparatively recent, and toward excessive gravity where old geologic formations occur at the surface, is full of inconsistencies, and is weak except for the two extremes, the Cenozoic and the pre-Cambrian. It is very suggestive that as the number of stations considered was increased the evidence has become more clear and convincing. The writer believes that the apparent relation cited is real and that it is important to determine, if possible, the true reason why the relation exists. At this, as at many other points, Mr. Bowie is properly cautious in interpretation, though vigorous in presenting the facts and in calling attention to the evidence of relations between the facts.

Mr. Bowie examined fourteen pairs of gravity stations in which the two stations of each pair are at very different elevations, although they are separated by a comparatively short distance in a horizontal sense. In one typical pair, one station, Yavapai, Arizona, is on the edge of the Grand Canyon of the Colorado, and the other station of the pair, although only 2,600 meters away in the horizontal sense, is 1,330 meters lower, in the bottom of the canyon. It is found that in thirteen of the fourteen cases the anomalies remaining on the Coast and Geodetic Survey basis of computation are such that if the anomaly at the lower station is subtracted from the anomaly at the higher station the remainder is positive. The average of the fourteen differences is + .014 dyne. This seemed to indicate that there is some error in the formula used to compute the correction to gravity for elevation. But "a careful study of the matter showed no error in the formula, but it seemed to indicate that the difference in the anomalies could result from the combination of several causes no one of which could alone make the difference."

Mr. Bowie has made an extensive, ingenious and careful study to determine from gravity observations the most probable depth of compensation. The methods of study and the results are fully set forth in the publication. Much difficulty was encountered arising from the intimate manner in which this unknown quantity is unavoidably entangled with other unknowns in the computations, and from the non-sensitiveness of the computed results to an assumed change of depth. There is also some evidence of systematic errors affecting the computed depth. Nevertheless Mr. Bowie has succeeded in getting from the gravity observations an independent determination of the depth of compensation. His conclusion is that the most probable value of the depth of compensation is 96 kilometers and that future values "derived from much more extensive data will fall between 80 and 130 kilometers." Having a keen realization of the difficulties of determining the depth of compensation, the writer recognizes this as a welcome confirmation of the independent and stronger determination of the depth by means of observed deflections of the vertical. The conclusion from the deflections of the vertical in 1910 was that the most probable value of the depth of compensation is 122 kilometers and that it is practically certain that it lies between 100 and 140 kilometers.[3]

Both these computations of the limiting depth of compensation are based upon the assumption that the compensation is uniformly distributed with respect to depth. In each case also the value is believed to be the average depth, it being conceded that the depth may possibly be different in different regions.

Mr. Bowie has computed the reciprocal of the flattening of the earth from gravity observations at 348 stations, of which 216 are in the United States and the remainder in Canada, India and Europe, and finds it to be

[3] "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy," by John F. Hayford, published by the Coast and Geodetic Survey, p. 77.

297.4 ± 1.0. The value of this quantity derived in 1910 from observed deflections of the vertical in the United States was 297.0 ± 0.5.[4] The very close agreement between these two independent values, an agreement which is well within the probable error of either one, is strong evidence both of a very high degree of accuracy of each and of very successful elimination of systematic errors.

Helmert's value of 1915 is 296.7 ± 0.4. It is based upon 410 gravity stations in various parts of the world. These stations were selected carefully with reference to their relation to topography, a precaution which is necessary with Helmert's method of computation, though not with Mr. Bowie's method. Helmert's method of computation differs radically from that used by Mr. Bowie, yet the two end results are in close agreement.

It is the writer's opinion that Mr. Bowie's monograph on the topic "Investigations of Gravity and Isostasy," is a notable contribution to geodesy. It furnishes a new and broader basis for further studies by geologists and students of geophysics. It furnishes new evidence of the steadily increasing skill and energy with which the Coast and Geodetic Survey is attacking the scientific problems which come within its scope. It is hoped that this article touching upon a few of the main points in the monograph will help arouse such interest as will lead to study of the monograph itself.

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THE NATIONAL ACADEMY OF SCIENCES

THE following abstracts have been received of the papers to be presented at the stated meeting of the National Academy of Sciences to be held in Washington on April 16, 17 and 18.

Sex-Determination and Sex-Differentiation in Mammals: FRANK R. LILLIE, The University of Chicago.

Sex-*determination* in mammals is zygotic, but it does not imply an irreversible tendency to the indicated sex-*differentiation.* Intensification of the male factors of the female zygote from the time of onset of sexual differentiation by action of male sex hormones may bring about very extensive reversal of the indicated sex-differentiation. This result is attained by a study of the twins of cattle. The way is open for an experimental examination of the limits of such reversal, and for an examination of the possibilities in the case of the male zygote.

Sporogony of Malaria Parasites: Photomicrographs of Infected Anopheles: W. V. KING, Ph.D., Bureau of Entomology. (Introduced by L. O. Howard.)

The cycle of development through which malaria parasites pass in the body of anopheline mosquitoes has been described in more or less detail by several authors. The illustrations of the developmental phases are, however, mostly taken from drawings which are often schematic and in some cases misleading. The opportunity is therefore taken for presenting the accompanying series of photomicrographs representative of the various stages in the complete sporogonic cycle, and a brief explanatory description of the development as observed in fresh preparations of infected mosquitoes. A few differences from the description as given in some of the texts have been observed and these are substantiated by the illustrations. The work was done in the laboratory of Dr. C. C. Bass, Tulane University, New Orleans.

The Great Barrier Reef of Queensland, Australia: W. M. DAVIS.

In recent years a number of students of coral reefs have concluded that the Great Barrier Reef of Queensland has been built up on a slightly submerged platform, of origin independent of coral growth and presumably similar to that of the continental shelf which borders the eastern coast of Australia, south of the limits of coral reefs.

There is, however, good reason to think that the present immature reef is an upgrowth from a submerged mature reef plain of an earlier time, if the changes of level that have taken place in the highlands inland from the coast are considered. Following the studies of E. C. Andrews, of Sydney, the highlands of eastern Australia in the region near the boundary between New South Wales and Queensland show the work of several cycles of erosion, each separated by an uplift of several hundred or a thousand feet. When these uplifts took place, the off-shore belt must have been de-

[4] "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy," p. 77.

pressed and the line of no change must have migrated westward toward the land, because in spite of the repeated uplifts, there are no belts of marine deposits along the shore line. The last of these changes is comparatively recent. It was preceded by a long period of still-stand, during which the border of the mainland was worn down to low relief, even though it consisted of rather resistant rocks. Preceding that still-stand period, a tilting similar to the one that has recently taken place raised the land area and depressed the marine area. Inasmuch as the recent tilting introduced reef growth, there is every reason to think that the earlier tilting also introduced reef growth; but while the reef of recent introduction is still immature, because of its youth, the reef of the earlier cycle must have reached advanced maturity in the long still-stand that followed its beginning, and thus its original lagoon area must have been converted into a reef plain, overlapped by deltas built out from the initial shore lines of that time. It is on the outer part of this reef plain, now submerged, that the present reef appears to have grown up. The fact that, contemporary with both cycles of reef formations off the Queensland coast, a continental shelf was in process of formation by unimpeded marine action off the coast of New South Wales, in no wise invalidates the above conclusions: the two processes are going on at the same time on adjoining coasts now; they may have been similarly synchronous and neighborly at earlier times also.

Searching for a Doubtful Geological Zone in the Canadian Rockies: Charles D. Walcott.

The stratigraphic position of the Mount Whyte formation of the Cambrian system in the Canadian Rockies having been questioned, I searched for evidence of its place during the field season of 1916 and found that it forms the upper member of the Lower Cambrian terrane both from the evidence of its contained fauna and its stratigraphic position. This conclusion is supported by the sections of the Cambrian formations in the Lake Champlain and the Lower St. Lawrence valleys.

The Influence of Diet upon the Heat Production During Mechanical Work in the Dog: R. J. Anderson and Graham Lusk.

The energy production in a dog moving at the rate of about three miles per hour is the same whether he be given no food or 70 grams of glucose. However, when the dog is given meat the increase in energy production during exercise is equal to the sum of the increases which the two influences of exercise and chemical stimulation through the metabolism of amino-acids would individually have induced.

What Determines the Natural Duration of Life? Jacques Loeb and J. H. Northrop.

Each species seems to have a characteristic average duration of life. In order to find out the nature of the variables responsible for this duration, experiments were made on the temperature coefficient for the duration of life of an insect (*Drosophila*). The experiments were carried out on breeds free from all microorganisms to avoid the objection that bacterial poisons formed in the intestine influenced the result. It was found that the temperature coefficient was of the order of that of a chemical reaction as we had found previously in non-sterile cultures. This result means that the duration of life is due either to the cumulative formation of harmful substances in the normal metabolism of the body leading to the phenomenon of old age and death; or that it is due to the gradual elimination or destruction of substances without which life becomes impossible.

The Difference in the Action of Antipyretics according to Species of Animals Subjected to this Action, the State of Health of the Animals, the Height of their Normal Temperature and the Substance Employed: T. S. Githens (by invitation) and S. J. Meltzer. From the Department of Physiology and Pharmacology of the Rockefeller Institute.

The principal point of this communication, arrived at by experimental observations, consists in the fact that subcutaneous injections of antipyretics administered to healthy hens, roosters and pigeons, whose normal temperature is regularly higher than that of normal mammals, reduces the temperature by several degrees centigrade, while injections of corresponding doses of the drug into healthy mammals have only either a slight effect or none at all On the other hand, pyramidon reduces perceptibly the normal temperature in both classes of animals. In human beings all antipyretics reduce febrile temperatures more or less strongly, while the normal temperature is affected by them only slightly.

SCIENTIFIC EVENTS

NITROGENOUS COMPOUNDS IN GERMANY

According to an article in the *Revue générale des Sciences* by Professor Camille Matignon abstracted in *Nature,* before the war Germany was the greatest consumer of combined nitrogen. In 1913 the consumption

amounted to 750,000 tons of Chilean nitrate, 35,000 tons of Norwegian nitrate, 46,000 tons of ammonium sulphate, and 30,000 tons of cyanamide. In 1913 great efforts were devoted in Germany to the preparation of materials necessary for war, and no attempt was made to conceal them. The German Ammonium Sulphate Syndicate had a reserve of 43,000 tons, and on the declaration of war there was probably a stock of 100,000 tons of Chilean nitrate. Immediately after the battle of the Marne, when a long war was evidently certain, the production of artificial nitrates and of ammonium sulphate was stimulated, the Badische Aniline Company and Bayer and Co. being subsidized to the extent of 30,000,000 marks for the installation of factories to convert ammonia into nitric acid. In peace time 550,000 tons of ammonium sulphate were produced annually in Germany, but this output was reduced once war was declared. As this substance is a by-product in the manufacture of gas and cast-iron, people in Germany were instigated to use gas and coke instead of coal, and by such means an annual output of 250,000 tons of ammonium sulphate was attained.

The problem of converting the ammonia into nitric acid was solved by the Frank and Caro and the Kayser processes. A French chemist, Kuhlmann, had discovered that ammonia is oxidized to nitrogen peroxide when mixed with air and passed over warm, finely divided platinum. The reaction was employed on a commercial scale by Ostwald, and improved both by Kayser and by Frank and Caro. By the end of 1915 the Anhaltische Maschinenbau Society of Berlin had established thirty installations for the conversion by Frank and Caro's process, and these had a capacity of more than 100,000 tons of nitric acid per month. But this was only one of the methods adopted. Given a cheap source of electrical energy, it was known to be commercially practicable to prepare nitric acid by the direct oxidation of nitrogen in the electric flame, and this process had been established in Norway by Birkeland and Eyde, who used the waterfalls as a source of energy. The Germans have established a factory employing Pauling's process (a modification of that of Birkeland and Eyde) at Muhlenstein, in Saxony, in the neighborhood of the lignite beds, which form the source of energy, and this has an annual output of 6,000 tons of nitric acid.

The third principal method adopted for the preparation of combined nitrogen was the direct synthesis of ammonia. Bosch and Mittasch, two chemical engineers of the Badische Company, had adapted Haber's synthesis to industrial conditions, and the company had established a factory with an annual output of 30,000 tons of synthetic ammonium sulphate. In April, 1914, the company increased its capital in order to raise the output to 130,000 tons, and after the battle of the Marne it was subsidized by the German government to increase the production to 300,000 tons.

Before the war the production of cyanamide in Germany was comparatively small, but it has increased largely under government stimulus. In the direction of the manufacture of manures, it was necessary to economize sulphuric acid, so ammonia was neutralized with nitre cake, and the resulting mixture of sodium and ammonium sulphates was mixed with superphosphate. Moreover, it was found that superphosphate will absorb gaseous ammonia, and although the calcium acid phosphate is thereby converted into the insoluble tricalcic phosphate, it is formed in an easily assimilable condition, and the product is found by experience to act both as a nitrogen and phosphorus manure.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND INDUSTRIAL RESEARCH

While offering every facility of the laboratories of the Massachusetts Institute of Technology to the United States government for any research in which it with its staff of trained professors can be of service, the institute holds that in addition to the education of its students it has an important function in being helpful to the industrial world. An agreement with Technology by the U. S. Smelting, Refining and Mining Co., to be in force in April, whereby the latter is to avail itself of the

laboratory facilities offered by the institute, is the latest step in forming closer relationships with the industrial world. This Boston-controlled corporation is one of the two large companies of the kind in this country. With the ability of Technology to undertake the work, it has expressed itself, through its president, William G. Sharp, as desirous of availing itself of the advantages offered by the institute. Instead of establishing a private research laboratory of its own it will bring its problems to Technology.

The advantages which accrue to a corporation which makes such an agreement include the economy afforded by not being obliged to establish a laboratory parallelling that of the institute. Such laboratories are very costly, construction and equipment running into the scores of thousands. The institute presents a further advantage that no private laboratory can afford, in that it maintains a great group of allied laboratories. There are unlimited quantities of water, steam, electricity and anything else that is needed, a great library, a large active force for investigation in the student body and unequalled facilities for quick and satisfactory conferences with the instructing staff. Then there is the ease with which other laboratories may be called to help in the solution of any problem. So related are the different industries that hardly any problem lies entirely within the sphere of only one of them. Chemistry turns to electricity, metallurgy to both of these, while mechanical engineering is fundamental.

On the other hand there are advantages to the institute. It has a very costly equipment which it really holds in trust for the community. It is the duty of its officers to make the fullest returns possible. Every use of its facilities by the industrial world is a step towards the realization of its ideals. Cooperation like that with the United States Smelting Co., in the solution of industrial problems makes it the more valuable to the people and the more valuable it becomes the better the chance of greater importance in the future, with the better outlook for the carrying forward of research work that may be of general benefit. That the latter may truly be assured the institute has in its agreement the provision that publication of results be not unduly delayed.

To carry on the special work which this cooperation necessitates, the corporation of Technology has named Henry M. Schleicher, B.S., a graduate of 1910, to be research associate in charge of the work, the general direction resting on Professor H. O. Hoffman, professor of metallurgy. Mr. Schleicher since his graduation has been engaged in research work with two Boston firms, with especial attention to electrolytic separation and flotation.

CHEMISTRY AND THE WAR

The registrar of the Institute of Chemistry of Great Britain and Ireland, according to *The British Medical Journal,* prefaces an account he has written of the work done by chemists in the war by observing that the government has secured the guidance of chemists and other men of science to assist in the investigation of suggestions and inventions and to bring their knowledge and experience to bear on measures and devices of offense and defense. The country had come to rely so much on foreign sources of supply that means had to be found for dealing promptly and efficiently with the difficulties which arose so soon as importation was stopped by the war. The laboratories of universities and colleges quickly became small factories for the preparation of drugs and medicaments, and many were entrusted with the examination of materials used in the manufacture of explosives. Uniformity in method and the standardization of processes was secured, and students unfit for service with the colors were set to work under the supervision of their professors. Several hundred chemists were engaged to assist in the laboratories and in government and controlled establishments supplying armaments, munitions and other materials of war, and in some branches arrangements were made for probationary training. The staffs of the chemical department of Woolwich arsenal, and of the government laboratory responsible for the examination of foodstuffs and many other requirements of the expeditionary force, were

enlarged. A number of chemists were early given commissions in the army for scientific work, and after the employment of poisonous gases by the enemy men with training in chemistry were enlisted for service in the field. With the assistance of the universities and technical colleges, and various bodies interested in chemistry, an entirely new force was brought into existence; the officers were mainly selected from chemists who already held commissions, whilst non-commissioned officers with knowledge of chemistry were transferred from other units. Both Lord French and Sir Douglas Haig had in their dispatches spoken highly of the work done by this force, which was obtained entirely by voluntary enlistment. The majority of the university graduates and men possessing recognized diplomas who originally enlisted as corporals subsequently received commissions, and when the force was more completely organized a considerable number were transferred to the ministry of munitions. During the campaign against the rebels in South Africa and the Germans in Southwest Africa chemists were attached, by direction of General Botha, to the different brigades, and rendered valuable service. The experience gained in the campaign proves, the registrar thinks, that it is advisable that the state should have control of an organization of professional chemists which would at any time ensure their efficient service to meet the many requirements of the naval, military and air forces. Chemists were required to control the manufacture of munitions, explosives, metals, leather, rubber, oils, gases, food and drugs; for the analysis of all such materials and for research; on active service chemists were required to assist in the control of water supplies, in the detection of poison in streams, in the analysis of water and food, and in the disposal of sewage, and both at home and on active service to assist in devising safeguards against enemy contrivances of a scientific nature, in devising methods of offense, and to instruct the troops in such matters. In summing up the matter, it is said that

chemists have met the situation with a spirit of true patriotism and have been promptly organized for the service required of them. It is not too much to hope that, as the discoveries of science have been applied to the destruction of humanity, they may be devoted more and more to the furtherance of the arts of peace, to the uplifting of civilization, and the pacification of the world.

SCIENTIFIC NOTES AND NEWS

THE spring meeting of the Council of the American Association for the Advancement of Science will be held in Rooms 39–41, new building of the U. S. National Museum, Washington, D. C., on the afternoon of Tuesday, April 17, 1917, at 4:45 o'clock.

THE afternoon session of the National Academy of Sciences on April 17 will be devoted to the work of the National Research Council. Reports will be presented by George E. Hale, chairman, National Research Council; Charles D. Walcott, chairman, Military Committee; R. A. Millikan, chairman, Physics Committee; Marston T. Bogert, chairman, Chemistry Committe, and Victor C. Vaughan, chairman, Committee on Medicine and Hygiene.

THE evening lecture before the American Philosophical Society will be given in the hall of the Historical Society of Pennsylvania on April 13, by Dr. George E. Hale, his subject being "The Work of the Mount Wilson Observatory."

IT is reported that the Rockefeller Institute for Medical Research has appropriated $200,000 for the establishment of a hospital to be used for the instruction of surgeons in the Carrel-Dakin treatment of the wounded. It is expected that Dr. Alexis Carrel will be granted a leave of absence from France to return to New York and assume supervision of the work.

A COMMITTEE to perfect an organization for an effective mobilization of the medical resources of Massachusetts to aid in obtaining officers for the army and naval medical corps, and to arrange suitable instruction in medical military preparedness, has been formed and is called the Auxiliary Medical Committee for National Defense. Dr. R. P. Strong, professor of tropical medicine in the Harvard Medical School, has been chosen as permanent

chairman of the committee, and Dr. John Warren as temporary secretary.

The University of Pittsburgh has formed a Research Committee to cooperate with the National Research Council. Dr. George H. Clapp, president of the board of trustees, is chairman of this committee, and the other members are Messrs. Bacon, Brashear, Griffen, Guthrie, Holland, Lincoln, Schlesinger and Thorpe.

Dr. Charles Doolittle Walcott, secretary of the Smithsonian Institution, has been elected a corresponding member in the class of physical sciences of the Royal Academy of Sciences of Bologna, Italy.

Dr. A. Belopolsky, astrophysicist at the National Observatory at Pulkowa, Russia, has been promoted to the directorship in succession to the late Dr. Backlund.

Dr. John Stanley Plaskett, formerly in charge of the department of astrophysics in the Dominion Observatory at Ottawa, has been appointed director of the Dominion Astrophysical Observatory, which is being established at Victoria. The principal instrument of the observatory is a 72-inch reflecting telescope, the mounting for which is in place, and the mirror is nearing completion at the shops of the Brashear Company.

General George W. Goethals has notified Governor Edge, of New Jersey, that he will accept the position of state engineer, which was created under a special act during the present session of the legislature. General Goethals will have supervision over the projected system of highways, which will cost about $15,000,000.

Mr. Ezra Levin has been appointed muck crop specialist for the Michigan Agricultural College with field headquarters at Kalamazoo, Michigan. He will spend half of his time in extension work and the other half in research in the Michigan Agricultural Experiment Station.

Mr. Ray Nelson, formerly assistant in the Michigan Agricultural College Experiment Station, has been appointed plant pathologist for the Illinois Central Railroad.

The Sarah Berliner Fellowship for Scientific Research has been awarded to Dr. Marjorie O'Connell, of Columbia University and the American Museum of Natural History. Miss O'Connell has just completed and published a memoir on the "Habitat of the *Eurypterida*," and she will continue her investigations on the conditions of existence of extinct invertebrates, using the evidence furnished by their fossilized remains and by the characters of the strata which contain them.

The locality at Vero, Florida, from which fossil human remains have been obtained was visited in the latter part of March by Professor E. W. Berry, Dr. R. T. Chamberlin, Dr. E. H. Sellards and Mr. H. Gunter. The objects of the visit were to observe more closely the conditions under which the vertebrate fossils of the deposit are found and to add to the collection of fossil plants. The results will be subsequently published.

A party of ten students from the University of Illinois will utilize the Easter vacation in making a field study of the geologic features along the Ohio River in southern Illinois, under the leadership of Mr. Eliot Blackwelder. A second party under the guidance of Mr. W. S. Bayley will visit the eastern portion of the Ozark Mountains in Missouri, for special field work in economic geology.

Dr. Otto Folin, of Harvard University, will deliver on May 18 the third Mellon Lecture of the Society for Biological Research of the University of Pittsburgh Medical School. The subject of this lecture will be "Recent Biological Investigations on Blood and Urine, their Bearing on Clinical and Experimental Medicine."

At the annual meeting of the Michigan Academy of Sciences, Professor William H. Hobbs gave, on March 28, the presidential address on "The Making of Scientific Theories." This address will be printed in Science. On the evening of March 29 Professor R. W. Wood, of the Johns Hopkins University, gave a lecture on "Photographing the Invisible." On March 30 Professor George Sarton, of Har-

vard University, gave a lecture on Leonardo da Vinci.

Professor Edward B. Titchener, head of the department of psychology at Cornell University, recently gave a lecture at Princeton University on "The Association of Ideas."

Professor Ellwood B. Spear, of the Massachusetts Institute of Technology, recently delivered lectures on the chemistry of colloids before the Chemical Society of Northeastern College and the New England Chemistry Teachers Association. He also conducted a symposium on colloids at a meeting of the Northeastern Section of the American Chemical Society.

The Association for the Protection of the Adirondacks held its annual business meeting in the galleries of the National Arts Club, New York City, on April 11, 1917, when the Hon. George D. Pratt, state conservation commissioner, delivered an address on "The State Forest Preserve," illustrated with stereopticon views and moving pictures.

Sir Ernest H. Shackleton is returning to England by way of the United States and will lecture in several cities. On April 23 he will lecture before the Geographic Society of Chicago.

Professor Henry B. Cornwall, of Princeton University, died on April 1, at his home in Princeton. He was born at Southport, Conn., in 1844 and was graduated from Columbia University in 1864. Mr. Cornwall was professor of applied chemistry and mineralogy at Princeton University from 1873 to 1910, when he became emeritus professor.

Professor Orson Bennett Johnson, well known for his extensive explorations in the natural history of the Pacific Northwest, died at home in Seattle, Washington, on March 9, aged 69 years. His very large collection of insects has been bequeathed to the University of Washington.

The Rev. O. Pickard-Cambridge, F.R.S., author of works on arachnology, entomology and general natural history, died on March 9, at the age of eighty-eight years.

A sum of one million pounds is allotted in the estimates of the British government as a grant in aid to encourage scientific and industrial research in 1917–18. It will be paid to the account of the Imperial Trust, and any balance will not be surrendered at the close of the financial year. Grants will be made by the directions of a committee of the Privy Council over an agreed period. Following an expenditure of £20,000 in the current year, another £15,000 is needed to pay for the relief expedition fitted out by the admiralty to rescue members of the Imperial Transantarctic Expedition from Elephant Island and also in respect of one half of the expenses of the relief expedition sent in conjunction with the governments of Australia and New Zealand to Ross Sea.

Dr. George E. Hale, chairman of the National Defense Council, has sent the following cablegram to the Royal Society, London; the Academie des Sciences, Paris; the Academy of Sciences, Petrograd, and the Accademia dei Lincei, Rome:

> The entrance of the United States into the war unites our men of science with yours in a common cause. The National Academy of Sciences, acting through the National Research Council, which has been designated by President Wilson and the Council of National Defense to mobolize the research facilities of the country, would gladly cooperate in any scientific researches still underlying the solution of military or industrial problems.

The 1917 meeting of the Association of American Geographers will be held at the University of Chicago, on December 27, 28 and 29. The annual meeting of the National Council of Geography Teachers will probably be held at the same time and place.

Mr. Warren Knaus ('82) has donated to the Entomological Museum of the Kansas State Agricultural College, his valuable collection of Coleoptera. Ever since he was a student in the college, Mr. Knaus has spent practically all his spare time and vacations in collecting and studying Coleoptera. He has made many trips into the arid regions of Mexico, Arizona, Texas and New Mexico to collect insects. These trips have been pro-

ductive of many new species. His collection contains a number of species that are only found in one or two museums in the world, and these were furnished by Mr. Knaus. His collection will be kept as a separate one and will be known as the "Warren Knaus Collection."

The University of Michigan Biological Station, situated at Douglas Lake, Michigan, will open for the ninth season on July second for a period of eight weeks. Courses in natural history and ecology of animals and plants will be in charge of the following staff:

George R. La Rue, assistant professor of zoology in the University of Michigan, director of the biological station, and assistant professor of zoology.

Reuben Myron Strong, Ph.D., assistant professor of anatomy in Vanderbilt University, professor of zoology.

Max Mapes Ellis, Ph.D., Sc.D., assistant professor of biology in the University of Colorado, assistant professor of zoology.

Frank Caleb Gates, Ph.D., sometime instructor in botany in the University of the Philippines, assistant professor of botany.

John Henry Ehlers, Ph.D., instructor in botany in the University of Michigan, instructor in botany.

Richard Morris Holman, Ph.D., instructor in botany in the University of Michigan, instructor in botany.

Walter Koelz, A.B., assistant in zoology in the University of Michigan, instructor in zoology.

Clyde Bruce Stouffer, M.D., physician to the University of Michigan Health Service, physician to the Biological Station.

The station is open to investigators as well as to students who require direction. Inquiries should be addressed to Dr. George R. La Rue, director of the Biological Station, Ann Arbor, Michigan.

The Cambridge University Press has issued a collection of essays by Cambridge graduates entitled "Science and the Nation." Chemistry, Physical Research and Metals are discussed by Professors W. J. Pope and W. H. Bragg, and Mr. Rosenhain, of the National Physical Laboratory; Mathematics, by Professor E. W. Hobson; Botany, Forestry and Agriculture, by Mr. F. W. Keeble, director of the Royal Horticultural Gardens, Wisley, Mr. W. Dawson, Professors R. H. Biffen and T. B. Wood; Geology, by Dr. H. H. Thomas, secretary of the Geological Society of London; Medicine and Diseases, by Professors F. G. Hopkins and G. H. F. Nuttall and Dr. G. S. Graham-Smith; while Mr. W. H. R. Rivers deals with the government of subject peoples from the point of view of the anthropologist. The general object of these essays is to emphasize and illustrate the importance of pure science and of original research as bearing directly on national prosperity.

UNIVERSITY AND EDUCATIONAL NEWS

The Texas legislature has created a branch of the State Agricultural and Mechanical College to be situated at a point to be determined by a commission in the western part of the state. The legislature has also established two junior colleges to be situated at Stephenville and Arlington under the control of the trustees of the state college. The legislature appropriated two million dollars for the rural schools of the state.

The University of Oregon Medical School is about to expend \$115,000 for the construction of the first unit of their new laboratory building on Portland Heights. The new site, some twenty acres, was the gift of the Oregon and Washington Railroad and Navigation Co. Its altitude affords a wonderful view of the surrounding mountains and rivers.

Dr. Simon N. Patten, professor of political economy at the University of Pennsylvania, has been retired on the ground that he has attained the age of sixty-five years. Dr. Patten in a statement said the notification given him "raises the question of free speech."

Mr. F. A. Kennedy has resigned from the instructing staff of the mining and metallurgy department of the University of Wisconsin to become a consulting engineer.

Dr. G. E. Burget, of the department of physiology of Chicago University, has been appointed professor of physiology in the University of Oregon Medical School.

Dr. C. E. Ferree, of Bryn Mawr College, has been promoted to be professor of experimental psychology.

DISCUSSION AND CORRESPONDENCE

THE SONG OF THE GRASSHOPPER SPARROW (AMMODRAMUS SAVANNARUM AUSTRALIS MAYNARD)

For many years I have been interested in the song of the grasshopper sparrow. This sparrow appears to be fairly common around Washington, D. C. During the early part of the summer of 1916 I frequently heard its peculiar, insect-like, lisping notes, for the bird is more often heard than seen. One male, however, almost invariably perched upon a certain cedar tree in the National Cemetery, near the McClellan Gate, to deliver its dainty, high-pitched it-tip-i-ts-e-e-e-e-e-e-e-e-e-e. This particular bird sang in this manner for many mornings, always singing from the same favorite tree.

For many years I was familiar with this field sparrow around my home town, Oxford, Mass., and have often heard delivered a more complete song than the one usually described by practically all observers and ornithologists. The usual song, it-tip-i-ts-e-e-e-e-e-e-e-e-e-e, frequently terminated with a most remarkable series of faint, rapidly uttered, wild, ecstatic, flowing, warbler-like notes—an exuberant chippety-chippety-chippety, continued for six or eight seconds. This last performance appears to have been a sort of passion song and is remotely like a tiny edition of the oven bird's passionate outburst as it mounts into the air above the woodlands at night. This more complete song is not as commonly heard as the lisping monotone and I have never yet heard it elsewhere than in New England. I feel, however, that this wonderful little twittering rhapsody is a part of its true song, at least in some portions of its range.

In the literature referring to the habits of this sparrow I find only two references to this variation in its song. In "Birds of New York," Memoir 12, Vol. 2, by Elon Howard Eaton, an excellent description of the song by Gerald Thayer is cited. Thayer interprets the usual song as "sit-tit-ts-e-e-e-e-e-e-e-e-e-e-e-e." He does not regard this as the true song of the grasshopper sparrow, however. The true song which he heard was a "long, rambling twitter," uttered in a tone similar to that of the insect-like notes given above, although not as loud, and continuing as long as 10 to 12 seconds. Eaton says:

> This rolling twitter is uttered when the male and female are flying together over the meadows or seated near each other.

L. A. Fuertes has also heard this more complete song of the grasshopper sparrow and likens it to the twittering song of the prairie horned-lark heard at a considerable distance.

H. A. Allard

Washington, D. C.

DECORATIVE AND PICTORIAL ART

To the Editor of Science: As an artist, I was interested in the quotation on art, used as an apt illustration in the interesting article, "Education after the War," by Messrs. Franklin and MacNutt, in Science of December 15. The argument is based on a misconception of the relative values of decorative and pictorial art; a misconception which is entirely modern. The Greek or medieval potter or weaver would have been much surprised if, when he was decorating a jar or a fabric with conventional forms, he had been told that his art was less "living" than that of the picture maker. Pictorial art is no higher or more alive than decorative art; it is simply a different expression of the artist's feeling for the beautiful.

The artist who designed the angel, probably in mosaic, illustrated in the article, desired to fill a given space with a symmetrical arrangement of line, form and color, which would be pleasing to the eye. As he was decorating a church, this arrangement took the form, or rather became the symbol, of an angel. He pointed the thumbs because the pattern was thus improved and he put red spots on the hands because he wanted some bright color in that particular place. (Though for the matter of that, I know of no data which warrant our concluding that angels haven't pointed thumbs or red spots on their palms!) If he had been decorating a banqueting hall, he would have used some symbol of conviviality, such as grapes, or a figure of Bacchus, or whatever symbol was best adapted

to his purpose, *i. e.*, filling a given space with ornament pleasing to the eye.

Decorative art is limited by space, material, etc., and its interest often consists in the artist's effort to use these limitations; while the comparative freedom of pictorial art often causes it to degenerate into imitation—which, of course, is not art at all.

As the technic of art is properly a science, these remarks may not be entirely out of place.

MARGARET ARMSTRONG

THE PRESERVATION OF RECORDS

To THE EDITOR OF SCIENCE: On reading the article on "Our Duty to the Future," by Professor C. E. Vail, in the December number of the *Scientific Monthly*, it occurred to me that we have at hand, available without special expense, better means of leaving permanent records for the future than any of our predecessors. Practically all printing is done from electrotypes; these electrotypes are made of metals that are not readily corroded by atmospheric action and under proper storage conditions would be very permanent.

In the production of practically all great books, or other records, engravings, etc., electrotypes are used. After serving their purpose in printing the edition many times they are but slightly worn and could be stored compactly in fire-proof and earthquake-proof, dry vaults. Sets of electrotypes, such as those employed in printing the Encyclopedia Britannica, and other reference works, would provide for future generations a considerable knowledge of almost everything of importance pertaining to this era.

Generally speaking, the preservation of records in this way would cost no more than the bullion price of the metal involved in the plates, as otherwise the plates would be remelted and the metal used over.

JOHN S. WRIGHT

SCIENTIFIC BOOKS

How to know the Mosses. By ELIZABETH MARIE DUNHAM. Boston: Houghton, Mifflin Co., 1916. 287 pages, illustrated. $1.25.

This little book is intended as "a popular guide to the mosses of the Northeastern United States" according to its subtitle or, as the cover states, "This handbook of mosses—the first intended for use without a microscope—throws open a new and fascinating field of study to the amateur botanist and nature lover. Keys to 80 genera and descriptions of over 150 species are given." In view of the limitations, and considering how difficult it is to really know the mosses thoroughly, Mrs. Dunham's conscientious effort to introduce a few of our most abundant and easily recognized genera and species to a wider acquaintance will certainly lengthen the season of out-door pleasures and interests for those who love nature at all times of the year! For "the mosses and lichens love the damp shade and the wet frosty season when other plants fade." To acquire even a bowing acquaintance with 80 out of the 200 genera represented in our flora and grow to recognize 150 species out of nearly 3,000, is to learn to have eyes that see and appreciate the subtler beauties of form and color.

The drawings in the text and the full-page illustrations will be found helpful and with the exception of a few indispensable technical terms the book is free from pedantry and unnecessary verbiage.

E. G. BRITTON

NEW YORK BOTANICAL GARDEN

SPECIAL ARTICLES

THE EFFECT OF FINENESS OF DIVISION OF PULVERIZED LIMESTONE ON THE YIELD OF CRIMSON CLOVER AND LIME REQUIREMENT OF SOILS

THE practical significance which attaches to studies in the application of lime to soils is responsible for experimentation with pulverized limestone of varying degrees of fineness. Frear[1] cites, together with his own experiments, the comparatively few investigations pertaining to this problem. It has been stated by some authorities that limestone passing a 10-mesh sieve is satisfactory for field practise, while others have advocated material passing a 60-mesh sieve, some claiming that even finer pulverization is to be preferred. The following experiments were planned in 1914 to throw

[1] Frear, W., "Sour Soils and Liming," Dept. Agr. Penn. Bul. 261, 1915.

some light on the comparison of a uniform limestone, which had been subjected to varying degrees of pulverization, with calcium oxide. During the progress of the work, Thomas and Frear[2] published results which are similar to those obtained in the present instance.

Several soils which may be regarded as typical of rather extensive fertile areas were obtained through the courtesy of Drs. P. E. Brown, C. E. Thorne, C. A. Mooers, W. J. Schoene and W. P. Kelly; respectively designated as Carrington (Iowa) silt loam, Wooster (Ohio) silt loam, Cumberland (Tennessee) silt loam, Norfolk (Virginia) sandy loam, Sierra (California) sandy loam and Portsmouth (New Jersey) acid muck. Ten-pound earthenware pots were filled with soil and limestone of 20–40, 60–80, 100–200, 200 + mesh and calcium oxide (c. p.) were added in sufficient quantities to satisfy the lime requirements of the various soils as determined by the Veitch method. Fifteen crimson clover plants were grown in each pot maintained under optimum moisture conditions in the greenhouse. A summary of the results obtained on the five more important soils is recorded in Table I. It is evident that in general, in

TABLE I

Summary showing Relative Effect of Fineness of Division of Pulverized Limestone and CaO on the Yield of Crimson Clover on Various Soils

Treatment	Norfolk (Va.) Sandy Loam	Wooster (O.) Silt Loam	Carrington (Iowa) Silt Loam	Cumberland (Tenn.) Silt Loam	Av.
Check	100	100	100	100	100
20– 40-mesh limestone	112	357	127	134	183
60– 80-mesh limestone	138	364	123	243	217
100–200-mesh limestone	134	419	130	248	233
200+-mesh limestone	146	404	142	262	239
CaO	161	398	153	208	230

all the soils studied, there is an increase in crop yield (dry weight) as the fineness of the limestone is increased. Averaging the five soils it will be seen that the yields with 200-M. are fully one third again as large as where 20-M. limestone was employed, and practically double the yield on the unlimed pots. There is little choice, however, between the 200-M. limestone and calcium oxide, the former giving maximum results on the Ohio and Tennessee soils, while the latter proved superior on the Norfolk and Iowa soils.

An analysis of these crops for total nitrogen (Kjeldahl method) indicated the same general relationship, as is shown in Table II. Namely,

TABLE II

Summary showing Relative Effect of Fineness of Division of Pulverized Limestone and CaO on Total Nitrogen (in Gm.) of Crimson Clover on Various Soils

Treatment	Norfolk (Va.) Sandy Loam	Wooster (O.) Silt Loam	Carrington (Iowa) Silt Loam	Cumberland (Tenn.)	Av.
Check	100	100	100	100	100
20– 40-mesh limestone	159	438	117	136	213
60– 80-mesh limestone	236	475	128	355	299
100–200-mesh limestone	231	500	139	336	302
200 +-mesh limestone	255	475	154	373	314
CaO	268	438	157	300	291

as the fineness of division of limestone increased, the total nitrogen (in gm.) increased. Two-hundred-mesh limestone was again superior to calcium oxide in two of the four instances.

The California soil, being decidedly alkaline, responded unfavorably to the application of limestone. That is, the yield of clover as well as the total nitrogen decreased with increasing fineness of division of pulverized limestone. With the acid muck soil (Portsmouth), however, the results were similar to those obtained with the other typical soils, *i. e.*, an increase in fineness of division was responsible for an increase in crop yield and total nitrogen.

After the clover had been harvested, the lime requirements of the soils were again determined for the purpose of comparing the relative neutralizing efficiency of the different materials. As might be expected from theoretical considerations the lime requirement tended to decrease as a result of the applica-

[2] Thomas, W., and Frear, W., *Jour. Ind. Eng. Chem.*, Vol. 7, No. 12 (1915), p. 1,041.

TABLE III

Summary showing Relative Effect of Fineness of Division of Pulverized Limestone and CaO on the Decrease (in Per Cent.) of the Original Lime Requirement of Four Typical Soils

	folk (Va.) dy Loam				Av.
Check	0	0	0	0	0
20- 40-mesh limestone	35	34	32	33	34
60- 80-mesh limestone	54	95	58	58	66
100-200-mesh limestone	62	95	97	73	81
200 +-mesh limestone	65		97	80	83
CaO	62	51	89	65	67

tion of limestone increasing in fineness of division as shown in Table III. The calcium oxide does not appear to be quite as valuable as the 200-M. limestone, which may possibly be due to the fact that the former proved initially superior in neutralizing the acidity, but allowed a subsequent accumulation of acidity to take place, while the latter neutralized the acidity more gradually and in a more progressive manner.

The writer has experiments in progress which indicate that increasing the fineness of division of pulverized limestone is responsible for increasing the biological activities such as ammonification, nitrification and nitrogen-fixation. A study is also being made of the effect of leaching upon the relative efficiency of different finenesses of division of pulverized limestone, with and without ammonium sulphate. This is carried out in galvanized iron tanks (containing 130 lbs. of soil) which have stopcocks permitting the collection of drainage water. In a sandy soil the growth of four successive crops indicates that the 60-M. is superior to the 20-M. or the finer grades of limestone, probably because in such deep pots (17 in.) and such a light soil, the finer material is washed down below the root zone.

NICHOLAS KOPELOFF

RUTGERS COLLEGE,
NEW BRUNSWICK, N. J.,
November 8, 1916

ILLINOIS STATE ACADEMY OF SCIENCE

THE tenth annual meeting of the Illinois State Academy of Science was held at Knox College in Galesburg on February 23 and 24. About one hundred members and delegates and some two hundred citizens of Galesburg attended the various sessions. Over forty new members were elected. Four sessions were held, as follows:

Friday afternoon, a general session at which the following papers were read:

"Safeguarding the Food and Water Supply, a Function of the State," by E. H. S. Bailey.

"Wireless Transmission of Messages in the Olden Time," by Francis E. Nipher.

"Botanical Installation in the Field Museum of Natural History," by Chas. F. Millspaugh.

"The Purpose of Science Teaching in a University," by W. A. Noyes.

"Plant Ecology and its relation to Agriculture," by Warren G. Waterman.

"Activated Sludge Process of Sewage Treatment," by Edward Bartow.

"Contribution of the College to High-school Science Teaching," by John C. Hessler.

On Friday evening, the members of the academy and delegates present and over a hundred citizens of Galesburg enjoyed a banquet at the Galesburg Club. A special session, marking the tenth anniversary of the academy, immediately followed the dinner. At this session, remarks suitable to the occasion were made by the following delegates from other organizations: Professor F. E. Nipher, St. Louis, American Philosophical Society, Academy of Science of St. Louis; Dr. W. A. Noyes, Urbana, National Academy of Sciences; Professor J. E. Wells, Beloit, Connecticut Academy of Arts and Sciences; Professor H. S. Conard, Grinnell, Iowa Academy of Science; Professor E. H. S. Bailey, Lawrence, Kansas Academy of Science; Professor W. H. Hobbs, Ann Arbor, Michigan Academy of Science; Dr. H. S. Pepoon, Chicago, Chicago Academy of Science; Dr. C. W. East, Springfield, Illinois State Board of Health; Dr. F. W. DeWolf, Urbana, Illinois State Geological Survey; Dr. A. R. Crook, Springfield, Illinois State Museum; Mr. E. B. Vliet, Champaign, Chemical Club, University of Illinois; Professor Edward Bartow, Urbana, Illinois State Water Survey; Professor F. L. Stevens, Urbana, Bacteriological Club, University of Illinois.

The following had accepted invitations to be present at this program but were unable to be pres-

ent and responded by letters or telegrams: Dean C. H. Eigenmann, Bloomington, Indiana Academy of Science; Dr. J. B. Shaw, Urbana, Mathematics Club, University of Illinois.

In addition to the greetings brought by these delegates, the American Academy of Arts and Sciences, the California Academy of Sciences and the Ohio Academy of Sciences presented their felicitations by letter regretting that these could not be offered personally.

Dean Eigenmann's message was in the form of an eight-page telegram in which he reported a dream which he had lately experienced. He dreamed that he and his neighbor, Billy Sunday, had died and presented their credentials to his Satanic Majesty at the same time. It appeared that Billy's credentials were not good for permanent admission to the place, but he was allowed to look in and was greatly amazed to find that the numerous men of science whom he had condemned to the place were all there and having a thoroughly good time. They were carrying on all kinds of scientific experiments for which the high temperature was especially suitable, and had so improved the place that Billy longed for permission to remain.

This program lasted until a late hour, and President William Trelease was compelled to forego the reading of the presidential address which he had prepared on the suggestive title: The Producer, the Distributer and the Consumer.

The program for Saturday morning consisted of a symposium on the topic Public Health Problems. The following were the speakers and topics of this program:

Opening of the Symposium, by Dr. J. H. Beard.

"Infant Mortality as a Public Health Problem," by Miss Emma Duke.

"The Control of Infectious Disease," by Dr. C. W. East.

"Rural Sanitation," by Surgeon M. J. White.

"Relation of Water Supplies and Sewage Disposal to Public Health," by Mr. Paul Hansen.

"Cancer, as a Public Health Problem," by Dr. J. F. Percy.

The symposium was followed by a special lecture, complimentary to the people of Galesburg, on the topic "Earth Genesis," by Dr. T. C. Chamberlin, of Chicago University.

On Saturday afternoon, the academy was divided into three sections for the presentation of papers as follows:

SECTION I

Papers on Botany and Allied Subjects

"The Chestnut in Illinois," by William Trelease.

"Dwarf Shore Floras," by H. Walton Clark.

"The Primrose Rocks of Illinois," by H. S. Pepoon (lantern).

"A Dipterocarp Forest," by Frank C. Gates.

"Elementary Teaching of Stem Structure," by Henry S. Conard.

"A Contribution of Knowledge of Porto Rican Fungi," by F. L. Stevens.

"*Phyllachora* on Corn and a General Consideration of the Genus *Phyllachora*," by Nora E. Dalbey.

"*Alternaria* in Apple Spots, an Apple Rot caused by *Gliocladium viride*," by Frances Jean MacInnes.

"Notes on *Cephaleuros Virescens*," by Ruth Higley.

"New or Noteworthy Fungi from Porto Rico," by Ernest M. R. Lamkey.

"Two Porto Rican Plant Diseases," by L. E. Miles.

SECTION II

Papers on Zoology, Physiology and Allied Subjects

"Selection, Regression and Parent-Progeny Correlation in *Aphis avenae* Fab.," by H. E. Ewing.

"Collecting Snails in the Southwest," by James H. Ferriss.

"Amphibians and Reptiles of the Charleston Region," by T. L. Hankinson.

"Crane Town on the Spoon," by Dr. W. S. Strode.

"Mechanism regulating the Laying on and Loss of Flesh."

"The Cause of Exophthalmic Goiter," by W. E. Burge.

"The Effect of Starvation on the Catalase Content of Tissues," by Alma J. Neill.

"Recent Research in the Department of Household Science, University of Illinois," by Ruth Wheeler.

"The Content of a General Science Course," by J. F. Groves.

SECTION III

Papers on Physics, Chemistry, Geology and Allied Subjects

"The Origin of Desert Depression," by William Herbert Hobbs.

"The Thebes Sandstone and Orchard Creek Shale, and their Faunas," by T. E. Savage.

"The Physical History of the Upper Mississippi Valley During the Late Paleozoic," by Francis M. Van Tuyl.

"The Climatic History of Alaska, from a New Viewpoint," by Eliot Blackwelder.

"An Improved Form of High Vacuum, High Speed Mercury Vapor Air Pump" (lantern).

"A Simple Demonstration Tube for Exhibiting the Mercury Hammer, Glow by Mercury Friction and the Vaporization of Mercury at Reduced Pressures" (demonstration).

"Visible Color Effects in a Positive Ray Tube Containing Helium" (demonstration, lantern), by Chas. T. Knipp.

"A Study of Indoor Humidity" (lantern).

"The Rate of Combustion of Some Illinois Coals" (lantern), by F. D. Barber.

"Derivatives of Iso-Camphoric Acid," by Glen S. Skinner.

The officers elected for the ensuing year are as follows: Dr. J. C. Hessler, James Millikin University, Decatur, President; James H. Ferris, Joliet Vice-president; Professor T. L. Hankinson, State Normal School, Charleston, Treasurer; Professor J. L. Pricer, State Normal University, Normal, Secretary.

J. L. Pricer,
Secretary

Normal, Ill.

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 564th meeting of the society was held in the assembly hall of the Cosmos Club, Saturday, January 27, 1917, called to order at 8 P.M. by President Hay with 45 persons present.

Under the heading of brief notes, Messrs. W. L. McAtee and A. Wetmore made remarks on certain misconceptions as to the notes of some common species of birds and as to a theory of the migration of birds.

Under the heading exhibition of specimens, Dr. O. P. Hay showed a metacarpal of a horse with well-developed lateral metacarpals, and three fused metacarpals of a cow each with well-developed digits.

Dr. L. O. Howard commented on an enthusiastic antimosquito convention, which he had lately attended in New Jersey.

The regular program consisted of two communications:

Exploitation of Neglected Aquatic Resources: H. M. Smith.

Dr. Smith called attention to many forms of fishes not used as food by the American public, but which are of pleasing taste and good food value. Many of these have long been used for food by Europeans, especially about the North Sea. He gave a brief résumé of the discovery, disappearance, rediscovery of the tilefish and of its successful introduction to the consumer through exploitation by the Bureau of Fisheries. He then described the dogfish and its habits destructive to other fish and the losses caused by it to fishermen. He told of the efforts now being made by the Bureau of Fisheries to market the dogfish as a food. Under the name of grayfish it is now being successfully canned and marketed by some of the New England fisheries and by some of the salmon canneries on the Pacific coast during the winter months when salmon are unattainable. The canned meat not only constitutes one of the cheapest forms of protein now available, but the livers of the dogfish yield a valuable oil; the oviducts, eggs; and the skin a leather which has many possibilities. Discussion by Messrs. Ames, Bean and Doolittle.

Showers of Organic Matter: W. L. McAtee.

Under this heading Mr. McAtee gave a review of the various apocryphal and authentic instances in which hay, grain, various insects, encysted animalcules, worms, frogs, toads, fishes and birds had fallen from the sky. The explanation was offered that the objects had been carried aloft by violent currents of air.

The 565th meeting of the society was held in the assembly hall of the Cosmos Club, Saturday, February 10, 1917, called to order at 8 P.M., by President Hay with 30 persons present.

Two formal communications were presented:

A Mortality of Fishes on the West Coast of Florida: H. F. Taylor.

During the months of October and November, 1916, vast numbers of fishes were killed in the region mentioned, by some obscure cause. It appears to be a recurrence of the phenomenon observed in 1844, 1854, 1878, 1880, 1882, 1883, 1908. Of the dead fishes 63 species, representing 37 families, were identified. The animals killed were confined, with the exception of king crabs, sea urchins and sponges to the class Pisces. Various suggested causes were examined; foul Everglade water, diseases and volcanic eruptions are inadequate explanations. Evidence at hand seems rather to show that the cause of mortality was the release of occluded bottom gases, by small seismic disturbances, or possibly by abnormally large numbers of Peridinii. Mr. Taylor's paper was illustrated by lan-

tern-slide views of the region involved and of strips of shore showing the large numbers of stricken fishes. His paper was discussed by Messrs. Hay, Bartsch, Goldman, Radcliffe and others.

Changes in the Avifauna about Burlington, Iowa, 1885 to 1917: PAUL BARTSCH.

From 1885 to 1893 Dr. Bartsch was resident of Burlington and an enthusiastic bird collector. In the ideal conditions found for birds at Burlington he had recorded 275 species. Since 1893 he has been a sporadic visitor to Burlington, but has always retained his interest in the local avifauna. Passenger pigeons, Carolina parakeets, whooping and sandhill cranes, trumpeter swans were found about Burlington, but are no longer seen. The same is true of the Mississippi kite, the swallow-tailed kite, wild turkey and prairie chickens, the latter having been shot in times past from the speaker's porch. The prothonotary warbler, once common, appears to have gone northward. New birds now found at Burlington have come from the west, such as western meadowlark, red-shafted flicker. Other newcomers are the tufted tit and Carolina wren. Many of these changes are due to human agencies, some are unexplainable. Dr. Bartch's paper was discussed by Messrs. Hay, McAtee, Wilcox, Goldman, Jackson and others.

M. W. LYON, JR.,
Recording Secretary

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 507th meeting of the society was held at the New National Museum on February 20. The speaker of the afternoon was Dr. I. M. Casanowicz, of the New National Museum, who presented a paper on "The Fish in Cult, Myth and Symbol."

Dr. Casanowicz said: "The fish, as the inhabitant of the mysterious, indestructible, never-resting water, early impressed man deeply and was regarded by him as the genius and representative of the life-producing element." The speaker stated that one of the principal centers of ichthyolatry in antiquity was Syria, where a fish goddess named Derketo-Atargatios was worshipped as the personification of the fructifying power of the water. Belief in the fish as a medium of transformation and incarnation of spirits was noted among the ancients, while in later times the fish, next to the bird, seems to have been a symbol of the departed human soul. The fish as carrier of man across the water was illustrated by quotations from Herodotus and the Bible; and parallel narratives of a man being swallowed by a sea monster were quoted from Greek, Polynesian and Cherokee lore.

In conclusion the speaker stated that the fish was generally considered as a being of good omen, benevolent and beneficent toward man, and, by reason of its own great fertility, a symbol of increase and abundance.

THE 508th meeting of the society was held at the New National Museum, on March 6. This meeting was devoted to a general discussion, the subject being, "Problems connected with the Distribution of the Aboriginal Population of America." The speakers were Dr. John R. Swanton, Dr. Aleš Hrdlička, Dr. Truman Michelson, Professor William H. Holmes, Dr. Walter Hough, Dr. J. Walter Fewkes and Mr. Francis LaFlesche.

Dr. Swanton introduced the discussion by stating that the subject divided itself into a consideration of the distribution of aboriginal population in America quantitatively and qualitatively. "Populations," said Dr. Swanton, "may be classified qualitatively according to their physical characteristics, languages, cultural features, social organization and so on. Archeology has a bearing on all these." He gave as one of the principal problems to be considered the bearing of the data of each class on the generally admitted Asiatic origin of the American Indians and their diffusion from the northwest.

Dr. Hrdlička, speaking from the standpoint of physical anthropology, stated that the distribution of different physical types on the American continent has always been one of the main problems of his branch of science in this country. Dr. Michelson, speaking on the linguistics of the Indians, said: "There is no single type of language, no fundamental structure that is the same in all linguistic stocks, though we find resemblances between them." Dr. Holmes spoke briefly on the changes in the culture of the Indian which have been produced by environment; and Dr. Hough noted that transportation and artificial fire-making were essential to the early inhabitants of this continent. Dr. Fewkes called attention to the fact that early migrations in North and South America were determined in large measure by the mountain ranges and rivers, and by the food supply. Mr. LaFlesche stated that the ancient rites of the Siouan stock show that the migrations of the people were influenced by the search for food. The first animal mentioned in these rites is the elk, succeeded by the deer, and later by the buffalo, at which period the mention of corn appears for the first time.

FRANCES DENSMORE,
Secretary

SCIENCE

FRIDAY, APRIL 20, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-On-Hudson, N. Y.

OBSTACLES TO EDUCATIONAL PROGRESS[1]

IT is only a commonplace, I know, to say that the serious study of educational organization and administration is largely a product of the past quarter of a century, and that the largest contributions to our knowledge in these fields have been made by students during the sixteen years that belong to the twentieth century. Yet I need to say it as an introduction to the thesis I wish to set up. The past decade and a half have witnessed a remarkable change in attitude toward the study of education. Never before have so many capable men and women directed their attention to a serious study of educational theory and the problems surrounding the proper organization and administration of public education, and never before has the type of the men and women preparing for entrance to the state's educational service been so high as at present.

Schools of education, which now exist in nearly all our leading universities, are almost entirely a twentieth-century product, and are becoming so organized as to render an increasingly important service in training for educational leadership and service. Our knowledge on educational questions, derived in part from our administrative experience, is being rapidly organized into teaching form; fundamental principles in school organization and administration are being established; and a better trained body of administrative officers, with larger and broader vision as to means and ends

[1] Address of the vice-president and chairman of Section L, American Association for the Advancement of Science.

and the significance of public education, is being prepared and sent out. Numerous summer sessions of our leading colleges and universities are contributing much to the dissemination of this newly organized knowledge of administrative principles and procedure among those actively engaged in the educational service. Despite all these recent advances, though, in educational theory and in the organization of our knowledge of proper administrative action, in actual practise throughout the nation our progress at times seems most discouragingly slow. Only in city-school administration have we been able to make real advances, and these only in certain cities and certain sections of the country.

Another recent statement that has already become almost a commonplace is that public education, after the close of the present Great War, will of necessity become a much more important state service than it has ever been up to the present time. The great world changes which will follow in the decade or two after its close—social, industrial and political—are almost certain to be far-reaching and vast in extent, and probably will greatly modify many of our present educational conceptions, as well as many of our methods and practices in hitherto undreamed of ways. A much more fundamental education of our people, especially along industrial and technical and political lines, is almost certain to follow. Our present traditional practises and provincialism in the organization and administration of public education will have to be superseded by a larger and a more forward, as well as a more national outlook. If we are to play our proper part in world affairs in the future—politically, commercially, or industrially—our educational systems must be unified in aims and practises much more than is now the case, world and life needs must enter more largely than at present into the education provided for the masses of our children, and a better-informed intelligence than the local democratic mass must direct our educational efforts, while a much larger nationalism in education must take the place of our present provincialism in school affairs.

We have then to-day a new interest in proper educational organization and administration on the part of a small but an increasing number of selected men and women, and we are facing new national and international needs opening up ahead of us which will make heavy demands on those who possess training and competency for the educational service which will be called for. The number who see these rapidly enlarging educational needs and are securing training to meet the future demands is still far too small to supply the trained and competent educational leadership that will be needed, but this number may be expected to increase slowly as communities offer larger opportunities to such men and women to be of real service. The thesis I want to lay down this afternoon, then, is that it is the lack of opportunity to be of real service which has kept and is still keeping many competent men and women from entering upon or properly preparing for the public educational service; that this lack of opportunity for real service still is, and until the conditions are changed will continue to be, the greatest obstacle we have to face in securing rational educational progress for our country; and that satisfactory educational progress can not be expected until the obstructions created by present laws and practises in educational organization and administration are removed by new legislation. Let us see what are some of the more important of these obstacles.

With us everywhere public education is still largely a local affair. The unit of organization is the school district—city,

county or rural—and in a majority of our states the little democratic school district, inherited in the early days from Massachusetts, is the prevailing unit for the organization and administration of education, and nearly everywhere these little self-governing units are but loosely bound together in the county and state educational organizations. With regard to organization we do not have a national school system, and, aside from the assimilation of the foreign-born, it falls far short of national scope in either conception or purpose. Even our state educational systems exist rather in a uniform school code and in clerical and inspectional oversight than in helpful state supervision, and too often consist largely in the imposition of a general state uniformity on communities in unimportant matters, while neglecting the larger concerns of a broad educational policy for intelligent future development.

It is to the school district, then—rural, township, city or county—that we go for the ultimate source of educational organization and administration in this country. Some of our states have twelve to fifteen thousand such little units, actuated by no common purpose or policy and devoid of any proper conceptions as to the nature or purpose of education in a modern state. Over these, as represented by their popularly-elected trustees, is a county school official with statistical and clerical functions but with little real power, and over the county organization is a state educational official with similar limited powers. In a few of the North-Central states we find that the township has replaced the school district, with the county over it; while in the New England states the districts have been abolished in favor of the town, this in turn being responsible to the state. In a few other states, mostly southern, the county has been made the administrative unit, while in all the states we find the separate city school district, with more or less independent powers in organization and administration. Let us leave the city aside for a moment and examine the obstacles to educational progress as found in rural and county educational organization.

That rural education almost everywhere is in need of a radical reorganization and redirection is another commonplace statement. Too frequently our rural schools attain to but a small fraction of their possible efficiency and render but small service in improving the conditions surrounding life on the farm. Too frequently their management is shortsighted, their equipment poor, their instruction ineffective, and adequate supervision is too often entirely lacking. That such schools contribute but little to the improvement of rural life is well known. The trouble lies chiefly in that the system of organization and management still followed is half a century behind the times, and that, in consequence, there is no opportunity for men and women of adequate training and capable of real leadership to make themselves effective in the improvement of rural education and the conditions surrounding rural life.

The so-called district system, with its large powers for local control, represents democracy gone to seed, and it stands today as the most serious obstacle in the way of the improvement of rural education. What is needed is larger and more flexible units for the organization of instruction; larger units for taxation, with a resulting more general pooling of both the burdens and the advantages of education; and an administrative organization which will make possible a more rational administration of the education of those who live in the rural districts and small villages of our country. Rural educational progress will be promoted in proportion as the school district is abolished for larger units of organization and control.

While the ultra-conservative nature of the district system makes it a serious obstacle in the way of intelligent educational progress, hardly less important as a hindrance to the improvement of rural education is the political and local nature of the office of county superintendent of schools. In twenty-one of the forty-one American states having such an educational office, the person who ought to be the educational organizer and director of the public-school system of the county is, instead, merely another county political official, selected from among the body of the electorate at the county primary and elected at the county political election, serving but a short period in the office, confined largely to statistical and clerical duties, afraid to assume much responsibility for fear of the enemies he will make in the districts, and with little power to put any educational ideas he might have into effect in the administration of the schools of his county. Generally speaking, the office attracts but few men or women of real training or large capacity for service, and the better trained the superintendent may happen to be the shorter is likely to be his term of service. The office, if we neglect a few well-organized county-unit states, such as Maryland or Utah, offers no educational career to any one, and no premium whatever to any one to make any professional preparation for the organization or administration of rural education. In but few states can a man or woman hope to enter the work of county school supervision—a service of fundamental importance to the children of half our people—on the basis of educational competency, or to retain the office on the basis of efficient educational service. The result is that the office offers but a temporary job to the few local residents willing to consider political candidacy, and that in but few states do we find any county educational organization capable of rendering any real service in the solution of our increasingly important rural-life problem. In consequence the education of rural children is inadequate and misdirected, intelligent farmers leave the farm for town in order that their children may have proper educational advantages, but little attention is given to preparation for rural service by either our normal schools or our colleges of education, and but few men or women think of trying to make any preparation for the organization or direction of the work of our rural and small village schools.

Passing from the county to the state, we find something of the same conditions prevailing. In nearly three fourths of our states the chief educational office of the state labors under the same political incubus as does that of the county superintendency of schools. Due to the larger area for selection and the enlarged competition, better men are usually secured for the position. As yet, however, but little attention has been given to any serious study of the problems of state educational organization and administration, and the political basis of the selection of the chief educational officer for most of our states places no premium on any other than political preparation. The great improvement in the work of some of our state educational departments within recent years, aside from the states where non-partisan appointment from the nation at large has replaced political nomination and election from the state, has been due either to a state superintendent of superior ability rising above the limitations of his office or to the appointment of a number of state commissioners or agents or specialists, these having been provided for under special laws and given special powers of supervision and inspection. In but few of our states, though, can we as yet be said to have a well-thought-out educational policy which is being followed for the improvement of

education generally throughout the state. To change this condition the obstacle presented by the method now in vogue for choosing the chief state educational officer needs to be eliminated, with a view to opening up to the state a chance to go into the markets of the whole country with the money the state feels able to pay to secure the services of the best prepared person available for the work at hand. The office of state superintendent of public instruction is, potentially at least, a much more important office than that of president of the state university; actually it is far from being so. It is not difficult to imagine what would be the condition of our state universities if we had continually selected the presidents of these institutions from among the residents of the state and by the same methods that have prevailed for so long in the case of the chief educational officer of the school system of the state. An important line of progress for the near future, then, in the case of both state and county superintendencies of education, is the opening up of these offices to educational competition, as is now the case with high-school principalships and city school superintendents. That such a change would give much encouragement to the study of the important larger problems of national welfare which surround the proper organization and administration of state and county systems of public education, there can be little question.

Turning now to the city school district we find much better conditions prevailing in the matter of the selection of educational executives. City superintendencies and high-school and elementary-school principalships have for a long time been on an open competitive basis in all our better managed cities, and in such a prohibitive protective tariff against brains and competency from the outside has not prevailed. The selections by city boards of education have not always been of the best—frequently otherwise—but the possibilities of a career and a chance for constructive service have in general been kept open, and these have made their appeal to certain types of minds. As a result, it has been the problems of school organization and administration as they relate to cities which have awakened interest and been studied most carefully. An examination of our educational journals will show that it has been the problems of city school organization and administration that have filled their pages, and the announcements of courses in our normal schools and colleges of education show that it is the city problems which are being studied by their students. These are offered everywhere, but the number of institutions offering courses for the study of the principles underlying the proper organization and administration of state and county school systems is limited indeed. The city has offered the prizes for administrative competency and adequate professional preparation, and practically all who have trained for school administrative service have trained with service in the city as the end in view.

Yet even in city educational organization many obstacles to educational progress still remain. The most of these are survivals of the school district or village stage in our educational evolution, or they are obstacles that arise from the lack of any proper conception as to the fundamental principles underlying proper educational organization and administration on the part of the public. The proper organization and administration of a city school system has become a highly expert piece of administrative service, and adequate results are no longer possible if proper administrative procedure is continually interfered with by the well-meaning ignorance or the personal-friendship ideas of

school board members or city officials. It is along these lines that we to-day encounter the greatest obstacle to successful educational administration in our cities. While it would be easy to enumerate a dozen such, I will content myself with a mention of the three which seem to me to be the most important obstacles to intelligent educational progress in the administration of our city school systems.

The first of such obstacles I would enumerate arises where the school superintendency for the city has been made an integral part of the government of the city. The ordinary lawyer, city official or politician finds it hard to understand why students of educational administration object to the apparently perfectly logical position of the schools as a part of the city governmental organization. They regard the school service as on a plane of practical equality with other forms of municipal service, and would place it on the same level as the other city patronage departments of fire, parks, police, streets and public work. Instead, the school is and ought to be regarded as a creation of the state, ranking with the home and the church as an institution for the advancement of the public welfare by the training of the next generation of citizens, and the state must see that it is not reduced to local patronage ends. These other departments represent a municipal corporation, erected to carry out municipal ends; the school is a state corporation to carry out a great state purpose. The experience of our American cities has shown clearly that efficient school administration is promoted by the complete divorce of city government and school control. To make a school board dependent upon the city government for direction and finance, and subject it to the annual scramble for city funds, is to oppose a serious obstacle to proper educational progress and to subordinate the education of the children in the city to the exigencies of city government. As the directors of a state corporation, representing the most important interest of every community, the school board should be free to carry on its work and, within certain limits set by state law, to levy the necessary taxes, free from any interference by the mayor, council, or other city officials.

The second obstacle to proper educational progress in city school administration which I would enumerate is the confusion of functions and responsibilities as between the school board, on the one hand, and the executive officers which the board employs to direct the work of the schools, on the other. Such a confusion arises in part as a result of the rapid evolution of cities from school districts and villages, the tendency being to retain functions once exercised, and in part from a lack of any clear understanding, on the part of the representatives of the public, as to what they are elected to do.

Our laws quite generally give all legal authority to the school board. Only in a few recently reorganized cities operating under special charter does the superintendent of schools have any definite powers and responsibilities. Usually the board has everything, and the superintendent only what the board sees fit to grant him. If the board likes him and trusts him they may grant him wide latitude; if they do not they may take from him practically every power that is vital to the successful administration of a system of schools. Such cases have been so frequent in recent years as to preclude the necessity of mentioning them here. School boards in their ignorance or because of pique frequently harass a good superintendent; put the whole city school system into a state of uneasiness and dissatisfaction; and eventually drive the superintendent from office because he has tried to prevent the schools

from being subordinated to local political or personal ends.

School boards of this type interfere with the proper administration of the schools in almost every conceivable way. The writer could give fifty illustrations of the improper exercise of power on the part of city school boards and school-board members which have come to his attention during the past five years, almost all of them being against the best interests of the schools and interfering with their proper administration and development, and more than one good superintendent could be mentioned who has been driven from office by such confusion of functions. Our educational advance is irregular and in spots, and progress is frequently followed by retrogression. The large power of control now exercised by city boards of education, and the lack of any clear definition in our laws as to the rights and functions of the professional expert boards of education are directed by law to employ, is to-day one of the serious hindrances to satisfactory and enduring educational progress. That this condition tends to turn many young men of capacity away from school administration as a career, and certainly drives some of our experienced men into other occupations, can not be doubted. The remedy for this condition lies in legislation that will guarantee to every superintendent of schools a right to be present and be heard when any matter concerning the organization or administration of the schools is under consideration; the clear right of initiative in the selection, promotion and retention of subordinates; and the initiative in many other matters which concern the management of the schools. This will guarantee to the superintendent of schools what may be considered as rights in the interests of the schools, and would in no way interfere with the work of any board of education interested in proper school administration. While I have stated elsewhere that, in principle, it is perhaps wiser that the superintendent of schools should not be entitled to a vote, it may nevertheless become necessary, if our school boards are not otherwise controlled in their ignorant interference with the work of a good superintendent, to follow the practise of a number of our corporations and seat the superintendent *ex-officio* as a member of the board of directors, and with a right to a recorded vote on every important action taken.

A third obstacle to proper city educational progress is the short term—usually one year—for which our superintendents of schools are commonly elected. A trial period of one year may in some cases be desirable, but thereafter the period of election should be long enough—four or five year terms—to give the superintendent an opportunity to carry out a constructive educational policy. The present annual election is a splendid means of keeping superintendents in subjection to boards who want to manage affairs, and to eliminate easily all who can not be kept under perfect control. The short term, the uncertain tenure and the lack of power to do much in too many of our cities not only prevents capable men from rendering effective service to the communities which employ them, but also drives from the service men of ability and promise. The lack of any high professional standards, based on education and professional preparation, the want of a form of a professional state certificate for supervision, coupled with the short and uncertain tenure, also enables boards of education to drive good men from office and then fill their places by others of a much lower degree of professional competency.

If public education in the United States is to increase in importance as a great constructive undertaking of our people; if

after the Great War we are to be called upon to play a new part in world affairs calling for larger homogeneity and national purpose on the part of our people; and if we are soon to undertake new educational efforts along agricultural, industrial, technical and political lines, as now seems certain, it is of fundamental importance that we eliminate from the organization and administration of our schools these features which stand as serious obstacles to their development on a thoroughly professional basis. We must also so shape their administration as to offer good inducements to the best of our men and women to make careful preparation for public service as school administrators, and we must assure them entrance to the work on the basis of preparation and competency, a chance to perform useful and unobstructed service, and the possibility of desirable life careers in the work. That this is not the case today in our county and state educational service, or even in our city educational service to the extent that is desired, is largely due to the obstacles to educational progress, chiefly of a political and provincial type, which I have just enumerated.

ELLWOOD P. CUBBERLEY
STANFORD UNIVERSITY

HUNTER OR HUSBANDMAN[1]

THE assumption that all the wild life growing upon the land belongs to all the people, and that any one who can do so is free to take it, is, of course, a direct inheritance from the day when all the game belonged to the king; when the king could do no wrong. We, the people, have succeeded the king. We have acquired his rights and privileges—his right to kill, his right to overrun the fields of the farmer, his right to get something for nothing.

We need now to recognize that the day of wanton exploitation is past, and that we have entered upon an era of conservation during which we must live on the increase of nature's products that our own hands have secured for us; no longer something for nothing, but everything for care and forethought and the application of science to bettering the conditions of life.

The primary assumption should be that the region where farmers live is an agricultural community—not a howling wilderness or a hunting preserve.

Hunting there must be to satisfy the human craving for sport—sport of a kind that is normal to the growing up of every youth, and that is a legitimate part of a man's recreation. But hunting is, at best, a savage sport that is pursued with dangerous weapons; and it should be pursued in civilized society only in places set aside for the purpose. The farmer should possess his farm in peace. The part of the public that desires to hunt should have proper places provided, and these places should be publicly marked for hunting; and peaceful farms where the wild life is treasured should not have to be marked against it. As there are public waters stocked by the state in which any one may fish, so there should be public game and forest preserves where one may hunt.

The farmers want freedom from the nuisance of the hunters who are merely raiders and economic pirates, and should unite to secure it. Every man's farm should be his own, free from ravage by hunters, free from menace by guns. All its wild products should be in his own keeping, subject only to his neighbor's interests, rights and welfare. The farmer should be free to raise on his farm any kind of plant or animal without permit or license from any source. Such artificial barriers ought not to obstruct the path of forward-looking agricultural enterprises.

The conservation measures that will best secure these ends are those which will protect and preserve the wild life in suitable places and provide hunting for the future; for men will hunt, and many of the farmers themselves desire this sport. The measures already before us that will go farthest toward removing the hunter from the farmer's premises are these:

[1] Extract from an address recently delivered before an audience of farmers at the New York State College of Agriculture.

1. State game farms, where wild game may be propagated, for distribution to public and private preserves.

2. Reserves, where the wild life may be maintained—forest and game preserves.

There should be not only one great state preserve like the Adirondack State Park, but every county in the state of New York should have its own smaller reserve, made out of the waste land that is still cheap and available. There is land in every county of the state that would be of far more worth if put to raising timber and game. We have talked much about reforestation: we have practised it little.

Portions of such public reserves should be kept as sanctuaries, free alike from the hunter, the lumberman and the engineer; and in these every wild thing, not harmful to the public, should find a place, and should be let alone. These places would serve as centers of natural propagation and dispersal for wild game species; but they would also keep from extermination many other things in which the hunter is not interested.

They would serve the interests of the public at large by preserving to future generations some of the wealth of life with which nature has endowed our country. There are three important reasons why it should be preserved:

1. Its esthetic value. Many of the wild things, both plants and animals, are interesting and wonderfully beautiful.

2. Its educational value: many of these things are important for teaching purposes; and the youth has a right to know what the native life of his native land was like; otherwise he will not be able to understand its early history.

3. Its possibilities of undeveloped economic values. We are only at the beginning of knowledge how to best utilize our natural resources. We should not exterminate the wild species. We do not know what use the future will have for them. Though they are all products of the evolution of the ages, they may be quickly destroyed, as the history of the passing of the wild pigeon shows. Once gone, they are gone forever. The interest that the public has in keeping them is in the long run far more important than the interest of the hunter in shooting or the farmer in raising crops.

JAMES G. NEEDHAM

CORNELL UNIVERSITY

SCIENTIFIC EVENTS

THE TEACHERS' SCHOOL OF SCIENCE

THE Teachers' School of Science, Boston, announces a summer excursion to Alaska under the charge of Professor Geo. H. Barton. The party will leave Boston on July 6, and after a visit to Toronto, will pass through Lakes Huron and Superior, making a short stop at Sault Ste. Marie. It will then visit Fort Williams and Winnipeg, and spend four days at Jasper Park in the Mount Robson region, thence to Prince Rupert, along the Skeena River to Skagway by steamer, via the Inside Passage and the Lynn Canal (fiord), stopping at Wrangall and Juneau. The party will then go by rail over the White Pass and down the Yukon to Dawson by steamer. Returning, the party will visit Lake Atlin, Vancouver, Seattle and Tacoma, spend three days at Mount Ranier and five days in Glacier National Park. A day each will be spent in Chicago and Toronto, and thence the journey will be by steamer through the Thousand Islands and the Lachine Rapids to Montreal and rail to Boston.

The school will also give its annual field lessons in geology and botany. The schedule of the courses follows:

April 21, Fitchburg—Tourmaline crystals, beryl, mica, feldspar; bathylith, granite, concentric jointing; a monadnock.

April 28, Medford—Decomposition and disintegration (exceptional); frost action, talus.

May 5, Hudson—Bed of dolomite in mica schist, with wernerite, sahlite, titanite, etc.; drumlins and channels of a glacial stream.

May 12, Quincy—Bathylith, granite, erupted into Cambrian slates with much contact phenomena.

May 19, Cedar Grove—Transverse fault; anticlinal fold; melaphyr, tuffs, shale.

May 26, Brighton—Old lava flows; igneous intrusions and dykes; amygdaloidal melaphyr; quartz, epidote, calcite, etc., alteration minerals.

May 30, Annual Field Reunion, Wayside Inn and Nobscot.

June 2, Newton Center—Contemporaneous bed; overturned fold; thrust faults, joints.

June 9, 10, Mts. Tom and Holyoke, Connecticut Valley—Differential erosion; trap and sandstone; reptile footprints; volcanic bombs, etc.

June 17, Atlantic—Stratification folds, cleavage; puddingstone, sandstone, shales, tillite.

June 24, Nantasket—Interbedded tuffs and melaphyr; intersection dykes, baked slates.

THE UNIVERSITY OF MICHIGAN MEDICAL SCHOOL AND NATIONAL SERVICE

The faculty of the University of Michigan Medical School on April 2, 1917, passed the following resolutions:

1. It is the opinion of the faculty of the University of Michigan Medical School that in meeting the demands for medical officers in the national service, the military authorities should give first preference for enlistment to the members of the medical classes of the past two years, viz.: 1915 and 1916.

Note.—These young men have recently finished their medical courses and having taken in part or altogether their hospital training, should have the latest and best information in scientific medicine, and not having as yet established themselves in practise, are best fitted to be selected for military service.

2. In view of the probably urgent demands for trained medical men, the faculty of the University of Michigan Medical School desires to place itself on record as being ready and willing to make its courses of instruction continuous through the summers of 1917 and 1918. This proposition will be submitted to the various state boards of licensure for their approval.

Note.—If this provision goes into effect, a week after the close of the present session, the session of 1917–18 will begin. Those who are now juniors will become seniors and may be graduated in January, 1918.

Note.—In taking this step, not only the military demands upon the medical profession, but civil demands as well are taken into consideration.

3. Taking into consideration the future needs of the country for trained medical men, it is the opinion of the faculty of the University of Michigan Medical School that it is advisable for the undergraduate medical students to complete their course of instruction and not to enlist.

4. The faculty of the University of Michigan Medical School recommends that not less than two hours per week be set aside for the military drill of undergraduate students, and that in addition to the ordinary infantry drill, we recommend training along the lines developed by the Clinical Society of Albany, and known as the "Albany Plan."

Note.—The medical officer should first of all be a soldier. This is necessary in order to make him most efficient as a medical officer.

5. That copies of these resolutions be furnished for suggestions of approval or disapproval to the following bodies:

(1) The surgeons general of the army and navy.

(2) The National Medical Committee on Preparedness.

(3) The National Research Council.

(4) The faculties of other medical schools.

6. That a list of the graduates of the classes of 1915 and 1916, with their standing while in the school and their present addresses, be sent immediately to the surgeons general of the army and navy.

BRITISH GOVERNMENT GRANTS FOR SCIENTIFIC RESEARCH

When the establishment of a separate department of scientific and industrial research was announced in December last, Lord Crewe stated that the Chancellor of the Exchequer was prepared to advise the government to devote a sufficient sum to cover operations during the next five years on a scale which would provide four, or perhaps five, times as much for cooperative industrial research as had been spent for the whole purposes of research hitherto. We learn from *Nature* that the civil service estimates just issued include the sum of £1,038,050 to the department of scientific and industrial research, being a net increase of £998,050 upon last year's amount. Grants for investigations carried out by learned and scientific societies, etc., are estimated at £24,000, and grants to students and other persons

engaged in research at £6,000. These grants will be distributed by a committee of the privy council, on the recommendation of the advisory council, to promote the development of scientific and industrial research in the United Kingdom, and will be subject to such conditions as the committee may think necessary. The £1,000,000 grant in aid of industrial research will be paid to the account of the Imperial Trust for the encouragement of scientific and industrial research. The expenditure of the trust will be audited by the comptroller and auditor-general, but any balance remaining on the account will not be surrendered at the close of the financial year. Grants will be made by the directions of the committee of the privy council over an agreed period to approved trade associations for research, to supplement the funds of the associations, and payments in respect of such grants will not be liable to surrender by the grantees at the end of the financial year. We understood from Lord Crewe's remarks on December 1 that for the next five years or so about £200,000 a year would be available for scientific and industrial research, so that apparently the grant of £1,000,000 is the sum which is to be drawn upon for this purpose. The amount estimated for salaries, wages and allowances in the new department is £7,250, which includes £1,500 for the secretary and £850 for the assistant secretary. Travelling and incidental expenses are estimated to amount to £800.

SCIENTIFIC NOTES AND NEWS

THE annual meeting of the British Association for the Advancement of Science, arranged to be held at Bournemouth in September next, has been cancelled. The two main considerations which have led to this decision are the restriction of railway communication and difficulties of accommodation on account of buildings being required for various national purposes. There will probably be a meeting of the general committee of the association in London to receive reports and transact other business. The annual meeting will therefore be intermitted for the first time in the history of the association since 1831.

ACCORDING to a cable from Paris received at Washington on March 29, the Gaudry prize has been awarded by the Geological Society of France to Dr. Charles D. Walcott, secretary of the Smithsonian Institution. This medal was established by the will of the late Professor Albert Gaudry.

PROFESSOR C. S. SHERRINGTON, Waynflete professor of physiology in the University of Oxford, has been elected a corresponding member of the Bologna Academy of Sciences.

PROFESSOR FREDERICK E. CLEMENTS has resigned the chair of botany at the University of Minnesota to accept a position with the Carnegie Institution of Washington.

PROFESSOR ALBERT SAUVEUR, professor of metallurgy and metallography of Harvard University, has been given leave of absence for the first half of 1917–18.

DR. J. F. ILLINGWORTH, professor of entomology, College of Hawaii, Honolulu, has been granted a leave of absence for three years, in order that he may carry on investigations for the Queensland government. His headquarters will be at Gordonvale, Cairns, North Queensland, in the midst of the sugar growing section. An experiment station is to be developed, primarily for the study of the grub-pest, which is such a scourge in certain cane-growing areas.

IT is announced that Mr. A. D. Hall has been appointed permanent secretary to the British Board of Agriculture in succession to Sir Sydney Oliver, K.C.M.G., now resigned.

PROFESSOR W. J. CROOK has resigned from the South Dakota State School of Mines to engage in practical work.

MR. ALESSANDRO FABBRI has been appointed to the post of research associate in physiology in the American Museum of Natural History.

SIR W. E. GARSTIN and Major-General Sir G. K. Scott-Moncrieff have been elected honorary members of the Institution of Civil Engineers of Great Britain.

DR. DOUGLAS W. FRESHFIELD, president of the Royal Geographical Society, has been

elected an honorary member of the Russian Geographical Society.

SIR ERNEST RUTHERFORD, professor of physics, University of Manchester, has been elected a member of the Athenæum Club for eminence in science.

AT a recent meeting of the Royal Geographical Society the president (Mr. Douglas Freshfield) announced that the king had approved of the award of the Royal Medals for the present year as follows:

The Founders' Medal to Commander D. G. Hogarth, for his explorations and other geographical work in Asiatic Turkey, 1887–1911.

The Patrons' Medal to Brigadier-General Rawling, for his explorations in western Tibet and Rudok, 1903; his journey from Gyanste to Simla via Gartok, and his exploration in New Guinea, 1908.

The Victoria Medal is awarded to Dr. J. Scott Keltie for his eminent services to geography during his secretaryship of the society.

The other awards are as follows:

The Murchison grant to Rai Bahadur Lal Singh for his devoted work as surveyor to the expedition of Sir Aurel Stein.

The Back grant to the Rev. Walter Weston for his travels and explorations in the Japanese Alps—a district previously unknown to Europeans.

The Cuthbert Peak grant to Dr. A. M. Kollas for his explorations and ascent of new peaks in Sikkim and his investigation of the effects of high altitude.

The Gill Memorial to Mr. E. C. Wilton for his geographical work in southwestern China.

MR. HUBERT JARVIS, assistant entomologist of Queensland, made a trip to Hawaii during February. In spite of the brief time that Mr. Jarvis spent in the islands he was very successful in his mission, which was the securing of a considerable stock of the lantana Agromyzid flies for his government. The signal success of these flies in Hawaii, in preventing the seeding of this most troublesome weed, has led other countries to seek similar relief. This Agromyzid, which apparently is an unnamed species, was introduced into the Hawaiian Islands by Mr. Albert Koebele, many years ago.

THE directors of the Fenger Memorial Association have made a grant of $400 to Pierce McKenzie for support of chemical and other work under the direction of Dr. E. R. LeCount. He will study the brain and other tissues from cases of heat stroke in order to determine, if possible, better than now known, the cause of the high temperature in this condition.

THE Lane Medical lectures at Stanford University for the year 1917 will be delivered by Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, during the week beginning on October 8. There will be five lectures in all and they will be given on consecutive evenings, at 8 o'clock. The subject of the series will be: "Physical Basis and present Status of Specific Serum and Drug Therapy."

PROFESSOR MARTIN H. FISCHER, of the University of Cincinnati, addressed the New York Section of the Society of Chemical Industry, on April 13, on "Some Technical Aspects of Colloid Emulsion Chemistry."

ON March 20 Dr. David D. Whitney, of the University of Nebraska, delivered an address before the Science Club of the Kansas State Agricultural College on "The Determination of Sex." This address is the first of a series of addresses on scientific subjects of popular interest planned by the club this spring.

DR. ALEXANDER SCOTT, the retiring president of the British Chemical Society, delivered an address entitled "The Atomic Theory" at the annual meeting on March 29.

SIR J. WOLFE BARRY will deliver the "James Forrest" lecture before the British Institution of Civil Engineers on May 2, taking as his subject, "The Standardization of Engineering Materials and its Influence on the Trade and Prosperity of the Country."

LECTURES to be given at the Royal Institution, London, include two by Professor C. S. Sherrington, on "Tetanus: Its Prevention, Symptoms and Treatment," and on "Rhythmic Action in Muscle and in Nerve." Professor D'Arcy W. Thompson will give two lectures on laws of growth and form; and Professor William Bateson two on "Heredity." Among the Friday discourses will be one on the organs of hearing in relation to war by

Dr. Dundas Grant, another on the complexity of the chemical elements by Professor Soddy, and one on breathlessness by Mr. J. Barcroft.

A MEMORIAL tablet to the late Sir William Huggins and Lady Huggins, executed by Henry Pegram, has been placed in the crypt of St. Paul's Cathedral, and was unveiled on March 29. The president of the Royal Society and the president of the Royal Astronomical Society were the speakers.

DR. JOHN K. MITCHELL, noted as a neurologist and author, died at Philadelphia on April 10. He was fifty-seven years old, and was a son of the late Dr. S. Weir Mitchell.

THE death is announced of Professor Angelo Battelli, the distinguished Italian physicist. He was born at Macerata Feltria (Pesaro) in 1862, and held chairs successively at Cagliari, Padua and Pisa. He was a member of the Chamber of Deputies.

DR. H. F. E. JUNGERSEN, professor of zoology in the University of Copenhagen and director of the department of vertebrates in the university museum, died on February 6, aged sixty-three years.

J. RIEDINGER, professor of orthopedics at the University of Würzburg, has died at the age of fifty-two years.

THE death is also announced of G. Argento, professor of surgery at the University of Palermo, aged seventy. He took a prominent part in public health matters and the hygiene of the hospitals throughout Sicily.

IT is reported from San Antonio that there is widespread infection from hookworm among the troops from Alabama, Mississippi and Texas, but that the disease is now under control.

AT the recent St. Louis conference of agricultural experts looking to production of greater crops as an emergency measure, it was recommended that the congress appropriate $25,000,000 for use by the Secretary of Agriculture in such a campaign. Because of the world shortage of food, it is scarcely possible that the production of staple crops by the farmers of the United States can be too great this year, and it is recommended that boys under military age and men beyond the age and those physically disqualified should be enrolled in the national army for labor and production of food, munitions and supplies. Other recommendations are for creation of an agricultural body under the Council of National Defence to supervise agricultural matters and for the vesting of wide authority in the secretary of agriculture to regulate and standardize food production and distribution. The subcommittees and their chairmen were: Production and Labor, Dr. Henry J. Waters, president of Kansas State Agricultural College; Distribution, Clarence Ousley, of Texas; Organization, President W. O. Thompson, of Ohio State Agricultural College; Economy, J. M. Hamilton, of Montana.

THE report of the Philosophical Institute of Canterbury, New Zealand, for the year 1916, as abstracted in *Nature*, records that the council has recognized the importance of furthering the national movement to advance scientific research and extend the application of scientific knowledge. Addresses on "Education and our National Requirements" and "The Importance of Research to Industry and Commerce," by Mr. G. M. Thomson and Professor T. H. Easterfield, respectively, were arranged with these ends in view. In order that matters connected with research and the chemical application of science should be constantly watched, the council set up a special committee, with Dr. C. C. Farr as honorary secretary. The New Zealand Board of Industries, having invited the institute to send delegates to confer with the board on matters affecting post-war reconstruction, the council appointed the president, with Dr. Farr and Dr. Hilgendorf, to act. Application has been made for part of the £250 granted by the government for research; and investigations are being arranged on the phosphate rocks of Canterbury, the deterioration of apples in cold storage and the electrical prevention of frosting in orchards.

MR. CHARLES BAILEY, formerly connected with the firm of Messrs. Ralli Brothers in Manchester, has presented his herbarium of

British and foreign plants to the University of Manchester. The acquisition of this collection added to the existing herbarium of the Manchester Museum, and more particularly to the large and valuable collection of non-European plants presented to the university in 1904 by Mr. Cosmo Melvill when he retired from business in Manchester, places the university among the foremost of British institutions in respect of this necessary instrument of botanical study and research. The comprehensiveness of the collection may be gathered from the fact that the British portion contains no less than 87,000 separate sheets of mounted plants, while the European portion amounts to 295,000 sheets. Mr. Bailey has made generous provision for the cost of transference of his herbarium to Manchester, and also towards the expenses of completing the mounting of the specimens, so that it may be available for study and reference.

ANNOUNCEMENT is made of the establishment for the year 1917–18 in Nela Research Laboratory, National Lamp Works of General Electric Company, of two fellowships in physical research to be known as the "Charles F. Brush Fellowships." One fellowship, extending over the nine-month period of the academic year 1917–18 carries with it an honorarium of $600 and is open to men who have either completed a course of graduate work leading to the doctorate degree or who have had equivalent work, particularly in original research. The other fellowship, extending over the three-month summer period of 1917, carries with it an honorarium of $200, and is open to men who, having completed their academic work, and having begun to teach, desire to spend a summer in original research in Nela Research Laboratory. These fellowships are offered for the coming year through the generosity of Mr. Brush who desires thereby to stimulate interest in industrial physics and to make it possible for young men to undertake research work in physics in the environment of an industrial plant. The Nela Research Laboratory will provide space and all necessary facilities, and will have general supervision over the investigations, which must be consistent with the normal activities of the laboratory. Candidates for these fellowships are requested to apply to the director, Nela Research Laboratory, Nela Park, Cleveland, Ohio.

THE State Microscopical Society of Illinois has adopted the following resolution:

Resolved, That the State Microscopical Society of Illinois hereby approve the representations made on its behalf by our Mr. Henry F. Fuller at the federal hearing on the subject of the proposed Dunes Park, on October 20, 1916, stating the attitude of this society in favor of such establishment; and now, since an interested and active opposition to the proposal has been developed in certain quarters from land speculators, be it further

Resolved, That this society most earnestly urge upon the United States Department of the Interior, upon the United States Congress, soon to be in session, and upon the senators and representatives from Illinois and Indiana in particular, the prompt passage of a bill for the establishment of the Sand Dunes region on the southern shores of Lake Michigan as a United States national park; with provision for its proper maintenance, that this rare and wonderful bit of nature so close to the great centers of population may be preserved for our own and coming generations as a place for study and for recreation, a sanctuary of safety for the birds and beasts and insects, the flowers and trees, and all the wild free life of field and brook and forest and beach forever.

ALBERT MCCALLA, *Chairman,*
HENRY F. FULLER,
LESTER CURTIS, M.D.

THE Ecological Society of America has issued a handbook giving information relative to the scientific activities, travels, field and instrumental experience, laboratory and experimental work, and taxonomic specialties of the 307 members of the society. Copies can be secured by addressing the secretary-treasurer, Dr. Forrest Shreve, Tucson, Arizona.

THE completed laboratory building and plant houses of the Brooklyn Botanic Garden will be dedicated on April 19–21. There were planned formal exercises followed by a reception on Thursday evening, the 19th, sessions for the reading of scientific papers on Friday morning and afternoon, and on Saturday morning;

a popular scientific program on Friday evening, and a conference on Saturday afternoon with teachers in Brooklyn schools to consider how the Botanic Garden may become most useful to the schools in connection with their teaching of botany, nature study and geography. About fifty papers have been offered for the scientific programs. The principal address on Thursday evening was delivered by Professor John M. Coulter.

The D. O. Mills Expedition to the Southern Hemisphere, sent from the Lick Observatory and maintained at Santiago, Chile, for a number of years past by recurring gifts from the late D. O. Mills and Mr. Ogden Mills, is now to be continued for another five years, subscriptions for this purpose of one thousand dollars per annum each having been made for five years by Mr. Ogden Mills, Mr. William H. Crocker, Mr. F. W. Bradley, Mr. A. B. Spreckles and Mrs. William H. Crocker, and of one thousand dollars each for 1917–18 by Mr. W. B. Bourn and Mr. Gordon Blanding.

We learn from *Nature* that the agricultural institute of Alnarp proposes to devote a plot of its land and about £4,000 to the erection of a building for studies in heredity, under the direction of H. Nilsson-Ehle, the recently appointed professor at Lund. It will also provide a maintenance grant of £200 per annum. It is felt that such studies are of the greatest importance at this time, when Sweden is thrown on its own resources in the matter of food production, and the institute is convinced that any material sacrifices it may make for this purpose will be more than repaid by the economic results of the research, on which the institute will naturally have the first claim.

UNIVERSITY AND EDUCATIONAL NEWS

The new laboratory for chemistry at the University of Cincinnati was opened on April 7. The ceremonies took place at McMicken Hall, Judge Rufus B. Smith presiding. Mr. Emil Pollak made the formal presentation of the building. Dr. Lauder W. Jones replied on behalf of the department of chemistry, Dr. John Uri Lloyd on behalf of the American Chemical Society. The main address was made by Dr. Chas. E. Herty, who spoke on "The Swing of the Pendulum in Chemistry." A dinner, arranged by the Cincinnati Section of the American Chemical Society, was given at the Gibson.

The valuable engineering library of the late Robert Gillhan, of Kansas City, Mo., has been donated by his sister-in-law, Mrs. Albert Marty, to Drury College, Springfield, Mo. Among the collection of books are complete files of the chief engineering journals of America, handsomely bound in three-quarter Russian.

Several teaching fellowships in anatomy (including histology and embryology) and physiology (including physiological chemistry) have been authorized in the University of Minnesota, Minneapolis. These fellowships are renewable for a three years' term, with successive annual stipends of $500, $600 and $700, and lead to the degrees of M.A. and Ph.D. in the graduate school.

The trustees of Toledo University in special meeting on April 10 refused to accept the resignation of Professor Scott Nearing, dean of arts and sciences, formerly of the University of Pennsylvania.

The necessary alterations have been made to enable the department of anatomy at University College, London, to be opened for the reception of women medical students next October.

The George Washington University Medical Society, composed of the alumni and faculty of the medical school, at a recent meeting elected Dr. W. Ashby Frankland, president; Dr. Coursen B. Conklin, vice-president; Dr. Thomas Miller, secretary, and Dr. Edward G. Seibert, treasurer.

Dr. William Duane, physics, and Dr. Walter F. Dearborn, psychology, have been promoted to full professorships in Harvard University.

Donald Fraser McLeod, assistant professor of civil engineering at the University of Mis-

sisippi during the last four years, has been promoted to be professor of municipal engineering.

MR. D. KEILIN, of Magdalene College, Cambridge, has been appointed assistant to the Quick professor of biology.

DISCUSSION AND CORRESPONDENCE

THE RÔLE OF BOYLE'S LAW IN CLINICAL SPHYGMOMANOMETRY. A REPLY TO A. M. BLEILE

IN a paper read before the American Physiological Society Dr. Bleile[1] discusses an application of Boyle's law which I made in developing the theory of the oscillations of pressure produced in the compression chamber of a sphygmomanometer by the arterial pulse.[2] My statement of this law, worded so as to fit the conditions obtaining in my experiments, was as follows: ". . . the rise of pressure determined by the addition of a given volume of incompressible material to a confined, gas-filled space is proportional to the pressure of the gas filling the space." Dr. Bleile illustrates the action of the law by paraphrasing the example in my paper thus:

> With a given volume pulse change, if the arm band pressure is at 100 mm., the pulse wave shown by the arm band manometer would be *only half as great* as it would with the same volume pulse but with the arm band pressure at 200 mm.

He then goes on to say that

> upon testing this hypothesis by the help of a suitable physical model it is demonstrated that such is not the case. On the contrary, it is demonstrated that the oscillations of volume occupied by a given mass of gas produce inversely proportional oscillations of absolute pressure. Or, in other words, the absolute pressure of a given mass of gas is inversely proportional to the volume. . . . Therefore, the results of the present work are in harmony with Boyle's law but are contrary to Erlanger's hypothesis.

This statement would lead one to suppose that in my application of Boyle's law I have committed the mistake of making the relation between pressure and volume a direct instead of an inverse one. This, however, is not the case. If my statement of the law is compared with Dr. Bleile's, it will be found that in this respect there is not the slightest difference between them. Thus, to paraphrase my statement so as to make it conform with Dr. Bleile's, "the addition of a given volume of incompressible material" *reduces* the volume of the given mass of gas; this reduction causes a "*rise* of pressure," which "is proportional to the (initial) pressure of the gas filling the space." In this statement the relation between volume and pressure (italicized) obviously is an inverse one. What evidently confused Dr. Bleile is the introduction into my statement of the word "proportional" for the purpose of expressing the relation between the *initial pressure* of the confined gas and the *final pressure* developed upon reducing its volume. That this relation is correctly expressed can easily be, and has been, confirmed by the use of very simple apparatus.

Having made it clear that there is no discrepancy between my and Dr. Bleile's statements of Boyle's law, I now desire to add that Dr. Bleile is right in criticizing my *example* of the application of the law. For I inadvertently employed in the example the pressures read directly from the mercury manometer instead of the absolute pressures, though, in the form in which Dr. Bleile repeats it, the example is in perfect accord with Boyle's law, if it is understood that the pressures are absolute. The failure to express the pressure in absolute terms affects, however, only the magnitude of change, not its sign, and therefore does not alter in any material way the development of the theory of the compression oscillations; for my only object in invoking Boyle's law was to show that under the particular set of ideal conditions premised, namely a rigid compression chamber, a compressible transmitting medium and an inextensible artery, the amplitude of the pressure oscillations resulting from the filling and emptying of the artery must *increase* as the compressing pres-

[1] "An Application of Boyle's and Avogadro's Law to the Oscillations of the Manometer in Clinical Measurements of Blood Pressure," *Am. Jour. of Physiol.*, 1917, XLII., 603.

[2] "The Mechanism of the Oscillatory Criteria," *Am. Jour. of Physiol.*, 1916, XXXIX., 401.

sure increases from the diastolic to close to the systolic level. And it was shown that under approximately this set of conditions such is actually the case (see Figs. 10 and 11).

But even if Boyle's law did (and it actually does not) determine a diminution instead of an increase in the amplitude of oscillations with increasing compressing pressure, the development of the theory of compression oscillations would not have been affected in the least. For in the further development of the theory it is shown (Figs. 12 and 13) that under the influence of additional conditions obtaining in sphygmomanometry the consequences of Boyle's law become relatively so insignificant that the amplitude of oscillations, instead of increasing, as the compressing pressure rises from the diastolic to the systolic level, actually decreases.

Joseph Erlanger
Washington University Medical School,
St. Louis, Mo.

THE UNIT OF PRESSURE

To the Editor of Science: The announcement that the French Meteorological Service has, beginning January 1, 1917, decided to publish atmospheric pressure data in units of force instead of millimeters as heretofore, makes it necessary once more to call attention to the fact that the proper unit for the expression of pressure is not the *millibar* but the *kilobar*. The scientific reasons for this have been given elsewhere at length. Another valid reason, however, may be now mentioned.

There has recently been developed a new type of condensation high-vacuum pump. I refer to that of Professor Langmuir. Pressures as low as 10^{-5} bar have been obtained; and there is little doubt that very much lower pressures can be produced by cooling the bulb to be exhausted, in liquid air, so as to decrease the rate at which gases escape from the walls.

The unit *bar* is here used (and I believe this is the practise of the General Electric Company and will of course be followed by physicists, chemists and others working on allied problems) in its right sense, namely, the accelerating force of one dyne per square centimeter. This is 10^{-6} megabar. In the case of this type of pump we have a pressure of 10^{-11} megabar or 10^{-11} standard atmosphere.

The millibar then in daily use becomes what it properly is, 10^{-3} bar. The European Weather Services trying to express atmospheric pressures in millibars are in error, and the correct values are one million times greater.

Fortunately, it is an easy matter to change *mb* to *kb*. And this should be done on all tables, charts, etc., published by European meteorologists.

Alexander McAdie

A RELIEF MAP OF THE UNITED STATES

To the Editor of Science: With reference to the suggestion in Science of March 9, relative to a large relief map of the United States, may I be allowed to state that this is a matter which I often discussed with the late E. E. Howell, who at one time had it under serious consideration? It was then my view, to which I still adhere, that there was a limit in size for such objects, beyond which nothing was gained. This was particularly impressed upon me some years ago while studying some of the maps of celebrated battlefields in German museums. In these large models, details toward the center, on account of distance from the eye, were as inconspicuous as though on a smaller scale and closer at hand. In short, the effect of the enlarged map was wholly lost owing to the necessary distance of the observer. A small map near at hand would be much less expensive, and fully as satisfactory.

With Dr. Clarke's remarks in Science for March 23 I fully agree, data not being at hand for anything but the most general topographic features over a large portion of the area of the United States. The plan, as it appears to me, is wholly impracticable.

George P. Merrill
U. S. National Museum,
Washington, D. C.

QUOTATIONS

RESEARCH IN MEDICAL SCHOOLS

An important report[1] in this issue of *The Journal* shows that of the twenty-six founda-

[1] "Medical Research in Its Relation to Medical Schools." A Report by Drs. Frederic S. Lee, Richard M. Pearce and W. B. Cannon, composing

tions for medical research in this country. seventeen, or nearly two thirds, are in connection with medical schools. The report also intimates that the "great growth of the spirit of research in this country" accompanied "the phenomenal development which medicine has undergone in recent years." In fact, the growth of medical research has been in direct proportion to the increase in the number of full-time, salaried professors in medical schools. This increase has been influenced, to a certain extent at least, by the inclusion of the possession of full-time teachers and the conduct of resarch work as one of the ten requisites in the basis[2] on which the Council on Medical Education rated medical schools in its first published classification. Since full-time teachers were urged chiefly in the laboratory branches, the development of research has been most rapid in that division of the medical school. Only a few medical colleges were amply financed to provide full-time professors in clinical departments and, therefore, only a few have all departments, laboratory and clinical, carrying on active research. With larger numbers of full-time clinical professors medical research in medical schools will attain to a higher degree of efficiency than is possible where that research is in isolated laboratory departments. There can not fail to be better results where all departments of the medical school are interested and cooperating in research, since then any department has the advantage of all the resources of the medical school; any discovery may be tried out under adequate facilities and safeguards and its value established or disproved. In fact, a modern medical school, with its skilled faculty; with its laboratories thoroughly equipped for medical instruction and research, and with an abundance and variety of clinical material at its command, constitutes the ideal arrangement for medical research. On the other hand, the medical school can not reach its highest efficiency in teaching unless it is permeated by the spirit of investigation that is engendered by research. The student can not fail to be benefited. He appreciates better the importance of the fundamental medical branches; that the training in the medical school merely admits him to the field of medicine with its limitless possibilities for usefulness, and that his future success depends on investigation, on keen observation, on accuracy of judgment, and on the skill with which he applies his knowledge. Graduates of medical schools in which research is a prominent feature of the work will be better able than those of other schools to cope with the multiform problems which confront the modern practitioner of medicine.—*Journal of the American Medical Association.*

the Committee on Medical Research of the Association of American Medical Colleges, read at the Annual Meeting in Chicago, February 6, 1917.

2 "Essentials of an Acceptable Medical College." Report of the Council on Medical Education to the House of Delegates of the American Medical Association, June 6, 1910, *The Journal of the American Medical Association*, June 11, 1910, p. 1975, paragraph 12 and p. 1976, paragraph 8.

SCIENTIFIC BOOKS

Metamorphic Geology. By C. K. Leith and W. J. Mead. Henry Holt & Co., New York. 1915.

Metamorphism as defined by the authors embraces "all mineralogic, chemical and physical changes in rocks subsequent to their primary crystallization from magma." That is, it includes all changes produced by weathering, disintegration, decomposition and deposition by sedimentation or from solution, as well as those processes that solidify by crystallization and rearrangement, and thereby form crystalline schists. In this sense all rocks except unaltered igneous rocks are metamorphic rocks, namely, soils, sedimentary strata, and crystalline schists. While a comprehensive treatment of all manner of alterations which may take place in rock masses is the logical and satisfactory method, it would seem advisable to employ some other term for the whole process than metamorphism, which has acquired through long usage a more restricted application.

Naturally the subject is separated into two parts, that of the destructive alterations, and that of constructive ones, which, following

Van Hise, are designated as katamorphic and anamorphic.

The object of the book is said by the authors to be the presentation of the current knowledge of this comprehensive subject in some perspective by means of quantitative methods of comparison and discussion. They say "It is not a handbook of metamorphism in which one may expect to find an adequate description of metamorphic details." There is no description of a metamorphic rock anywhere in it. It is evidently prepared for students who have a knowledge of the petrography of all kinds of rocks, and the ability to determine minerals optically and chemically. It is, in fact, a book for advanced workers in petrology and for geologists interested in the broad problems of sedimentation and the redistribution of mineral matter in various ways.

The authors are unable to follow Van Hise in the emphasis he placed on his so-called zones of katamorphism and anamorphism, for, as they remark, so many other factors than depth enter into the processes of alteration that at any depth, or at the same depth at different times, the changes may be in opposite directions for different kinds of rocks. Or, as they have also expressed it, "Depth is only one of the factors determining intensity of conditions. Igneous intrusion, mineral and chemical composition, the differential stress conditions, etc., all play their parts."

In Part I. the decomposition, or katamorphism, of rocks is discussed with respect to several types of rocks as illustrated by specific instances, such as a granite from Georgia, and a gabbro or diabase. Another example is the production of bauxite from nephelite-syenite, which is called an "acid igneous rock," and the production of laterites from "basic" igneous rocks. The decompositions of ores and of sedimentary rocks are also discussed. In each case the mineral and chemical changes, as well as those of volume and density, are considered in general terms. This is followed by a speculative discussion of the probable redistribution of the constituents of the average crystalline and igneous rock during decomposition. The speculative character of the discussion rests upon its apparent quantitative elements, since it is necessary to assume definite quantitative values for factors concerning which there can be no definite quantitative knowledge. Moreover the petrographical basis of the discussion is open to serious question in that it assumes that all igneous rocks may be embraced under the terms "acid" and "basic," or granites and basalts (!), and that estimates of the average composition of these have definite values. The value of deductions derived from general averages of highly complex factors is always doubtful for the reason that an average is too often a graveyard of facts.

Part II. deals with the construction or integrating changes in rocks, or anamorphism. It includes cementation, dynamic metamorphism and contact or thermal metamorphism. Various types of rocks are considered with reference to these possible modes of transformation; clays, sands, carbonates, igneous rocks, mineral deposits and ores. The cleavage and textures of the crystalline schists are discussed at considerable length, and the discussion closes with a general review of the results of anamorphism and of the probable processes, the conclusions being of special interest and importance, but too extensive to be cited here.

There follows, in Part III., a general discussion of metamorphism in the broad sense in which the authors use the term, which is made to include a discussion of the origin of residual clays and soils, glacial deposits, transported clays and muds, sands and sandstones, calcareous sediments and crystalline schists. In the case of the schists it is found from an investigation of chemical data that "chemical criteria do not satisfactorily discriminate schists of sedimentary and igneous origin." They fail in those cases where other criteria fail. The discussion also considers ocean, lake, river and underground solutions as by-products of the metamorphic cycle, and the authors suggest that the metamorphic cycle be made the basis for the genetic classification of commercial mineral products.

In concluding the discussion they say that "The metamorphic cycle may be regarded as indicative of a great pulsational alteration of

the earth's surface, kept going through the running down of energy and its escape from the earth," and they remark further that this view of the significance of the metamorphic cycle involves a slight modification of the prevalent interpretation of Hutton's law of uniformitarianism in that while the same series of processes are operating to-day as in the past they are now working on different propositions and distributions of substances than formerly, with consequently slightly different results.

A fourth part of the book is devoted to suggestions as to laboratory work in metamorphism, which by reason of its very general character appears to have been prepared as suggestions for instructors of laboratory students rather than for the students themselves. The book is a valuable contribution to the broad geological problems connected with changes of all kinds which take place in rocks, but its title is somewhat misleading.

J. P. Iddings

SPECIAL ARTICLES

A PLANT MEMBRANE FOR DEMONSTRATING OSMOSIS

The writer has noted with interest that the authors of recently published text-books in botany are still advocating the use of egg membranes and parchment membranes for the demonstration of osmosis. It is unfortunate that botany teachers should limit themselves to animal membranes, parchment membranes, or celloidin membranes in demonstrating to students this very important phenomenon in plant physiology. This is especially true when we have readily available a natural plant membrane which serves the purpose admirably. I refer to the testa of the lima bean.

Osterhout[1] has suggested the use of the testa of the lima bean in some osmosis experiments of rather limited visual value. In the botanical laboratories of Kansas University Professor W. C. Stevens[2] has used this membrane in the type of osmosis demonstration providing for a rise of the more rapidly diffusing liquid in a glass tube of narrow diameter. In our own classes we have found the experiment so satisfactory that the method is here presented in detail.

Two days before the experiment is to be set up, place a number of clean lima beans on clean moist paper or absorbent cotton in a glass jar and cover with a glass plate. As germination progresses some of the seed coats will split almost as soon as swelling begins. Others will stretch greatly without splitting. The latter will best serve for the experiment. It is also important to discard any which show signs of bacterial or mold activity. After selecting the bean to be used carefully split the testes through the micropyle and hilium and remove the two halves. Each will serve as an osmotic membrane. Soak the membranes in water for a few minutes to remove any wrinkles. With ordinary narrow rubber bands fasten the membranes tightly over the smooth ends of two clean glass tubes with inside diameters of 4–7 mm. Sugar or salt solutions may now be run into the tubes from the open ends, using a wire or fine glass rod to direct the flow. The tubes should be filled to a height of two or more inches and the level marked with accuracy. Be careful to avoid bubbles. The tubes may now be supported vertically by ring stands with the bean testa in contact with water in a glass dish. The height of the liquid in the tube will rise almost immediately and will continue to do so for several days. The usual variations of such experiments as to the liquids used may be satisfactorily employed with this membrane.

The writer has found this experiment the most simple of the osmosis demonstrations to set up. Five minutes is adequate with the apparatus at hand. With ordinary care the results are satisfactory in nine cases out of ten. The students appreciate a real plant membrane to illustrate plant osmosis. It is advisable if time permits to set up the egg experiment also for its general biologic value.

As to the value of osmosis demonstrations in elementary college courses in botany, we use

[1] Osterhout, W. J. V., "Experiments with Plants," 1906.

[2] Shull, C. A., "Semipermeability of Seed Coats," *Bot. Gaz.*, LVI., 183, 1913.

them in our laboratory to emphasize differences in diffusibility between crystalloid and colloid solutions in studying the nature of protoplasm, to show the method of entrance of solutions into root hairs, and to illustrate a factor in the ascent of sap in stems. The experiments never grow old to the student of inquiring mind.

Orville Turner Wilson
University of Cincinnati

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

SECTION D—ENGINEERING

The first session was held in the morning of Thursday, December 28, in the engineering building, Columbia University, Vice-president Dr. Henry M. Howe in the chair, with an attendance of about 65. It was announced that the sectional committee had recommended for election to the general committee for the office of vice-president, Dr. Henry S. Drinker, president of Lehigh University, South Bethlehem, Pa. The following officers were elected by the Section:

Member of Council—Professor F. L. Bishop, of the University of Pittsburgh.

Member of General Committee—Professor D. D. Jackson, of Columbia University.

Member of Sectional Committee—Professor A. E. Burton, of the Massachusetts Institute of Technology.

The program of the session, which was devoted to sanitary engineering, was as follows:

The Treatment of Public Water Supplies: Nicholas S. Hill, Jr.

The Disposal of Sewage by Dilution in New York Harbor Waters: D. D. Jackson and R. H. Brown.

Pure Water and the Public Health: George A. Johnson.

Recent Developments in the Design of Garbage Disposal Plants: Gustave R. Tuska.

The Sterilization of Tannery Wastes: D. D. Jackson and A. M. Buswell.

The Situation regarding the Main Drainage of New York City: Kenneth Allen.

The second session was held on the afternoon of Thursday, December 28, in the assembly hall of the Automobile Club of America, under the joint auspices of the Society for the Promotion of Engineering Education, the Automobile Club of America, the National Highways Association, the National Automobile Chamber of Commerce, and Section D, American Association for the Advancement of Science. This session was devoted to highway engineering education. Mr. William O. Wiley, treasurer of the Society for the Promotion of Engineering Education, was in the chair. The attendance was about 85.

The program of the session was as follows:

The Value of a Training in the Humanities for Engineers: Nelson P. Lewis.

What is Best in Engineering Education: H. H. Higbie.

Education in engineering should be primarily a systematic cultivation of the natural abilities of the individual student, and should be concerned only secondarily with acquiring knowledge of facts or of methods of using them. The greatest services which a college may undertake to perform for its students are:

First: To develop traits and habits which produce a creditable and attractive personal address.

Second: To establish a habit of thinking independently, clearly, accurately, usefully and pleasurably.

Third: To ingrain thoroughly some fundamental principles of science to base thoughts upon.

Fourth: To exalt the personal ideals and morals of a student.

Colleges of engineering commonly attempt to impart other things, which the student is not likely to assimilate, namely:

1. Experience and judgment in the applications of scientific principles to practical problems.

2. Special knowledge, expertness or speed in any particular branch of science or art.

3. Equipment of knowledge adequate for any demand without some measure of ingenuity or adaptive ability on the students' part.

Any notable improvements in the functioning of an engineering college will depend upon:

1. Personality, interest, enthusiasm of the teachers and their contact with the students.

2. More general and serious study of educational problems by teachers of engineering.

3. Greater adaptability of the educational system to the individual student.

Criticisms and suggestions are made concerning the teaching of English and foreign languages, specialized or professional courses and mathematics.

Essential Qualifications of Highway Engineers for State, County and Municipal Departments: E. A. Stevens.

[1] New York, December 28–29, 1916.

The Objects of the Educational Campaign of the National Automobile Chamber of Commerce: Alfred Reeves.

Highway Engineering Electives in the Fourth Year of Civil Engineering Courses: Hector J. Hughes.

The demand for skilled highway engineers raises the question whether the engineering schools are providing the best training possible in this field; if not, should the situation be met by: (1) Specialized post-graduate courses; or (2) by specialized undergraduate courses in highway engineering; or (3) by offering a limited amount of specialized options in the fourth year? Post-graduate work following a good course in fundamentals offers a solution for those few men who can give the additional time and money, but most engineering students can not do so, and this limits the problem chiefly to the four-year courses. In the past, specialized courses have been organized to meet similar needs in other fields; but experience shows that training in the fundamentals is more important than specialized studies. Specialized four-year courses in highway engineering may make the students more successful for a few years after graduation, but the narrowness of such training is likely to limit their usefulness and their opportunities. It appears to be possible to provide in a well rounded four-year program the fundamentals of civil engineering and at the same time to offer small groups of electives in several of the most important special fields of civil engineering.

The Need for Highway Engineering Courses in Civil Engineering Curricula of Western Universities: T. R. Agg.

Limitations of Field and Laboratory Work in Highway Engineering in Civil Engineering Curricula: C. S. Farnham.

Subjects recommended for Inclusion in Civil Engineering Courses to qualify Graduates to enter the Field of Highway Engineering: Arthur H. Blanchard.

The papers and discussions presented at this session will be published in full in the *Bulletin* of the Society for the Promotion of Engineering Education.

The third session was held on the evening of Thursday, December 28, in the assembly hall of the Automobile Club of America under the joint auspices of the Automobile Club of America, the National Highways Association, the Motor Truck Club of America, the National Automobile Chamber of Commerce, the Citizens' Street Traffic Committee of Greater New York, and Section D, American Association for the Advancement of Science, Vice-president Dr. Henry M. Howe was in the chair. This session was devoted to highway engineering, and the attendance was about 130.

The program of the session was as follows:

The Interrelations of Seaport, Railroad and Highway Terminals: Calvin Tomkins.

Highways formerly were and railroads now are the principal land factors in transportation.

Definition of port terminal service.

Growing importance of motor trucks and highways as feeders to railroads and waterways—and for short hauls.

Breakdown of transportation at city terminals a consequence of difficulty in adapting and expanding these terminals to changing conditions.

Necessity for segregating terminal charges from transportation charges in order to obtain revenue to finance modern terminals.

Large proportion of railroad capital unprofitably invested in terminal properties which should be made public and integrated as administrative units.

Terminal reorganization involving parity of opportunity for all carriers and shippers and real-estate owners, interferes with vested interests based on bad terminal practises. Improvements are consequently delayed.

Rotary Traffic, Accomplishments and Possibilities: William P. Eno.

In 1903 the "rotary system" was suggested for Columbus Circle and put in use in 1905. In 1907 it was adopted at the Arc de Triomphe in Paris. Now it is in effect at all circles in all cities where there is any intelligent attempt to regulate traffic.

The "rotary system" could be made to replace the "block system" at simple intersections in all cases where there is sufficient turning space. It has been adopted in other cities but New York has so far failed to profit by it. Its installation on Fifth Avenue would largely eliminate blockades and would add at least 25 per cent. and possibly as much as 50 per cent. to the traffic capacity of the street. A fair trial could be made at such slight cost that the saving in one day by its operation would pay for the trial. It should therefore be put into effect without unnecessary delay and the "Go Go" semaphores should be discontinued as they are worse than nothing.

Recent Investigations of Tractive Resistance to Motor Trucks: A. E. Kennelly and O. R. Schurig.

Printed in Science, April 6, p. 341.

Speed Governors for Motor Trucks: THEODORE DOUGLAS.

There are various types of governors available of which about 95 per cent. are of the centrifugal variety. The constant-engine-speed governor ties up from 20 per cent. to 50 per cent. of the power capacity of the engine and sacrifices both gasoline and engine efficiency. The constant-vehicle-speed governor regulates only the vehicle speed and sacrifices the engine through allowing a prohibitive speed on low gears, and no control at all in idling. It is shown that the *ideal governor* would be a combination of the constant-engine-speed and the constant-vehicle-speed governors. A governor of this combination type is now available in the industry.

This governor may be broadly described as a combination of two-speed controls operating a single centrifugal unit and actuating a single valve. This is accomplished through the employment of two springless pawl clutches so designed that each may overrun the other. Whether the speed from the engine or from the vehicle is the higher speed, that speed will engage the centrifugal unit and close the valve.

By the use of the combination type governor, truck efficiencies have been largely increased, and a perfect automatic control has been supplied.

Factors controlling Maximum Overall Dimensions of Motor Trucks: ALFRED F. MASURY.

Traffic Census Analysis: WILLIAM H. CONNELL.

In order to work out a suitable highway design, it is necessary to make a study of the traffic conditions, and upon the collection of adequate data and its careful analysis may be based: (*a*) the plan of a highway with respect to its lines, grades, widths and location of roadways, footways and lawn areas; (*b*) the design of a pavement surface and base best suited to the traffic requirements; (*c*) an estimate of the probable relation between traffic service and maintenance costs; (*d*) the character and time of cleaning best suited to the prevailing types of traffic; and (*e*) the physical regulation of traffic with respect to the direction of flow, crossings, parking areas, safety islands and zones, and safety and regulating signals.

The several lines of investigation which are necessary to a comprehensive traffic study may be indicated as follows: (*a*) the survey, which determines the nature of the existing physical and other conditions influencing or relating to the traffic; (*b*) the census, which records the quantity, character and weight of traffic; and (*c*) the planning, through which it is sought to develop a more consistent relation between traffic requirements and traffic provision.

In most traffic census, it has been the general practise to consider "ton of traffic per foot width of pavement" as a proper unit. It would seem that the most logical and satisfactory unit of traffic measurement would be the "ton-mile" or its multiples per foot of maximum travelled width of pavement.

The Most Satisfactory and Economical Pavement for Parkway Drives: SAMUEL WHINERY.

Present Status of Preliminary Location and Mapping of National Highways proposed by the National Highways Association: CHARLES HENRY DAVIS.

Possible Variations of Physical Properties of Rock from One Quarry: CHARLES P. BERKEY.

Stone and Concrete Foundations from the Standpoint of Efficiency and Economy: GEORGE C. WARREN.

The words "Efficiency and Economy" each in their broadest sense mean practically the same thing and the same as the word "best," when considered in its broadest sense of "all things considered."

There is no one "best" for all conditions and an engineer who would recommend any one type of pavement surface or foundation as universally best, would be like an architect who specified one class of building material as best for all buildings, *i. e.*, a "man of one idea."

In determining the character of foundation best suited for any particular case, the engineer or road-builder should give most careful consideration to the character of subsoil, traffic, wearing surface to be laid on the foundation, and climatic conditions.

Block pavements of all kinds should be almost universally laid on concrete foundations. Monolithic bituminous pavement surfaces depending on stability of the surface and local conditions outlined above, may be laid on either rolled broken stone or concrete foundations.

Concrete includes any dense combination of mineral aggregates in which the coarser sizes predominate artificially bound together with either Portland, bituminous, or any other type of cement.

Generally speaking, broken-stone foundation is adapted for cases where the rolled subgrade is of a character of material which can be solidly compressed. It has been found that sand provides a good sub-base provided the sand is sprinkled during the rolling of the broken stone, thus providing a sub-base condition like damp sand on the beach.

Concrete foundations should be used on weak subsoil of clay, etc. Portland cement concrete roads and foundations crack, causing corresponding cracks in the pavement surface, which is retarded by the use of either broken stone or bituminous concrete foundation. Bituminous pavement surfaces are more liable to creep on Portland cement concrete than on broken stone or bituminous concrete foundations, as in the latter cases the surface and foundation are firmly united to each other. Portland cement concrete foundations should be used where a maximum rigidity is essential.

Present Status of Bituminous Surfaces on Gravel Roads: John R. Rablin.

Value of Physical Tests on Bituminous Aggregates: Prevost Hubbard.

Proportions of Ingredients of Bituminous Mortars Used for Fillers: Phillip P. Sharples.

Bituminous mortars used for fillers in block pavements have been used in the United States of America since 1913. These fillers consist of mixtures of coal tar pitch and sand, or asphalt and sand. Specifications for both kinds were adopted at the 1916 meeting of the American Society of Municipal Improvements.

These bituminous mortars are particularly well adapted for use in filling the joints of stone block, brick, lug wood block and Durax pavements. Observation shows that the asphalt-sand mastic does not fill the joints as well as the pitch-sand mortar, owing to the higher melting point of the former and its lower adhesive value.

Summary.—Those bituminous mortar fillers that have given trouble to date have done so because not sufficient sand was originally mixed with the bitumen. A fine sand gives much better results than a coarse sand, and more of it can be introduced in the mastic. By properly heating and applying, a mastic with equal parts, by volume, of sand and bitumen can be forced into the joints of block pavements. For special conditions, special grades of bitumens must be used. Hand mixing is cheaper than machine mixing, and as good. The pouring method should be entirely dispensed with and the flushing and squeegeeing method substituted.

Present Status of Physical Tests for Granite Blocks: C. D. Pollock.

This paper gives the progress made in tests of granite for paving blocks and reviews the changes made in such tests in standard specifications which have been in very general use.

Even the latest tests are far from ideal, as the conditions which prevail in the tests do not approximate those which exist in actual traffic on the pavements.

Engineers are now studying this question and undoubtedly will work out some tests which will more nearly conform to the wear and tear of the traffic on the granite block pavements in the street.

The service test at the present time is the only sure and reliable test.

Joint Fillers for Granite Block Pavements: Herman H. Schmidt.

In this paper the development of the granite block pavement is traced from the first granite pavement laid which resembles our modern granite pavement, up to the present highly improved granite pavement, as laid in our large cities.

A detailed statement of the requirements of ideal joint fillers is given, followed by a discussion of the various joint fillers used and available. In this discussion the defects in each are pointed out, and the writer suggests what in his estimation would be an ideal joint filler.

There is also a brief discussion of methods for applying joint filler, and mention is made of the character of the cushion course which will give best results.

The writer's conclusion is that with slight changes in the methods of work and improvement in the character of joint filler, granite pavement will have reached the highest state of development of which it is capable.

The Real Sources of Trouble in Brick Pavements: Maurice B. Greenough.

The most common imperfections in brick pavements are caused by non-enforcement of adequate specifications reflecting the best procedure of modern methods. One hundred per cent. construction is not possible of attainment under some specifications in force which are indefinitely worded and incomplete. Few imperfections are caused by brick of poor quality. The American Society for Testing Materials has adopted procedures which, if followed, insure securing the required degree of quality in the brick. Monolithic construction, while not a panacea for all brick pavement troubles, eliminates the hazards of a faultily prepared sand cushion and affords a large measure of protection against most brick pavement imperfections.

A. H. Blanchard,
Secretary

(To be concluded)

SCIENCE

FRIDAY, APRIL 27, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-On-Hudson, N. Y.

PERSONALITY AS REVEALED BY THE CONTENT OF IMAGES[1]

CHARACTER study and the investigation of personality have recently assumed, on account of the present tendency to apply psychology, a psychological importance they did not formerly possess, and since it has given rise to a general interest in any work looking towards the possibility of getting additional information regarding the individual consciousness, it has seemed to me I could not do better to-day than to outline the results of an investigation which I have made to ascertain whether it is possible through the examination of the content of an individual's images to obtain an insight into the predominating features of his personality, that is, the psychical and physical activities which characterize and distinguish him from others.

The experiments were made with 20 persons, largely professors and students connected with the Stanford University. In half of these experiments (S.) the observers allowed visual images to arise of themselves and in the other half (V.) they aroused them. It is scarcely necessary to add that the experiments were "*unwissentlich.*"

The most important fact that comes out in examining the tabulated results and what was given to protocol is *that visual images reveal the mental and physical peculiarities and preferences of an individual.*

In what follows, I shall take up in detail the results of but 3 observers, to show that the data ob-

[1] Address of the vice-president and chairman of Section H, Anthropology and Psychology, American Association for the Advancement of Science, New York meeting, December, 1916.

tained reveals the observer's personality, that is, his mental and physical activities as shown by what has been stated concerning him in "Who's Who in America" (W.), "American Men of Science" (C.), his general reputation in the university community, the opinion that his intimate friends have of him, my own knowledge of him, and by what he himself said at the close of the experiments when questioned regarding the personality-revealing power of the content of the images he had reported.

The first individual results to which I wish to direct especial attention are those obtained with R.—(C.W.)—professor of electrical engineering at Stanford University, formerly at Cornell. Born in 1866. Has not traveled in Europe. At the time of the experiments was preparing for a demonstration and discussion at the approaching summer meeting of the American Association for the Advancement of Science of the insulation of electric currents at high voltage.

R.'s images for the most part as regards frequency follow the general time law. The interesting peculiarities to note are that the willed images have, more frequently than the spontaneous, an imaginative character, and that the future gives more images in the case of willed images than of spontaneous. That is, the imagination images are concerned with the future; they have a creative rather than a reminiscent character and have more largely to do with electrical work. The difference in content between the spontaneous and willed images of R. is due doubtless to the course of training as regards the putting aside of his electrical and, indeed, of all work of an inventive character during the hours devoted to rest, which he has been obliged to give himself in order to restore and preserve his health.

R.'s images are connected with the east, where he has engaged in electrical work, with Stanford University, especially his laboratory and home, with the Panama-Pacific Exposition in San Francisco, with Owens Valley and La Jolla, where he watched the construction of the Los Angeles Aquatic Power Project as consulting electrical engineer, and with places where he has gone on pleasure excursions in his automobile, as, for example, a series of views on a drive from San Francisco and San José to Stanford.

People, interiors (his own laboratory, particularly), electrical instruments and machinery, automobiles, electric cars and landscapes, especially the scenes along a country road, are evidently of the greatest interest to R. It is noticeable that when he uses his will, not people or landscapes are the image-producers, but his work as an electrician, the improvement and adaptation of electrical instruments and machinery that he contemplates taking up in the near future in getting ready for the demonstration just mentioned.

Through curtailed summary just given of the content of R's images I am able to give but a very general idea of the information conveyed through them regarding his mental and physical activities. The results, however, obtained with him and with the other observers do show that through using the image method one is able to obtain very detailed information regarding a person's individual peculiarities.

W.—Major in history, Stanford University. Born 1890 in Los Angeles, where his family has since lived. Captain of the baseball team. Visited Japan and Hawaiian Islands with the team in 1913. The experiments were made during the baseball training season.

W.'s spontaneous images are largely confined to the present and to Stanford University. Those that are willed also include images of the trip he made with the team. His Stanford images show that his thought is taken up with the men of the baseball team, the athletic field, the training house, and with other places and things connected with the playing of baseball. The images give, without doubt, a true picture of the life of a college student devoted to athletics. It is said this observer has been tempted to give up the idea he formerly had of going into scientific farming and has even seriously considered devoting himself to professional baseball. One is made to realize more fully in examining these images how college athletics may largely absorb a student's thought and become, as in this case, a menace as far as the particular student is concerned to the college itself as an intellectual center.

FF.—Born in Palo Alto in 1901 and has lived there continuously, except for a year and a half spent in the eastern part of the United States and the eleven summers of perhaps four weeks each, spent at Carmel, and the four summers of eight weeks each at Tahoe. Up to within a year or so she studied at home, but is now in a private school.

As to time, FF.'s images follow the law, except that their number is greater in 1909–07 than in 1911–10. This is probably due to the fact that a year and a half of this time was spent in the eastern part of the United States, for the majority of the images of this period are reproductions of occurrences connected with this eastern visit.

As to location, FF.'s images have to do with Palo Alto (her home, school, etc.), the places where her summers have been largely spent (Carmel and Tahoe) and with the experiences, as was said, of the year and a half residence in the east. The year in the east, considering the time involved, has a very much greater image-producing power than has her own home in Palo Alto. The same is true of her life at Carmel and Lake Tahoe, the last furnishing more images than does Carmel, where she spent more time and the time was more distributed. The importance of vacation periods in the intellectual life clearly comes out here, as well as in case of some of the other reagents.

I suspect the pleasure-giving power of an image often determines its arousal in FF.'s case. At any rate, no image of her experiences at Carmel in 1906, when she had scarlet fever and suffered a great deal, arose, and moreover, every one of her images has an agreeable content and she showed much pleasure in describing them. Not only pleasure, but the newness of an experience is also, doubtless, an important factor as regards its being imaged. This explains probably why FF. reproduces in her images so rarely the members of her own family, to whom she is devoted. One must not, however, over-emphasize pleasure and interest as image-producing factors in her case, for the results show other factors often enter in and control their arising. For example, FF. went to the Exposition two days during the time the experiments were being carried on and was greatly interested and took much pleasure in what she had seen, but the fifteen images recorded after her return from the Exposition do not reproduce what she saw there.

FF.'s predominating interests are evidently those enumerated by her mother, before she knew the distribution of her images—Tahoe, Carmel, people, school, horses, in fact, all animals, plants, especially flowers, water and landscapes. Some of the images classed under people had a landscape background or were accompanied by another image-arousing subject such as an animal; a person, for example, was on horseback, or a dog or cat was with a person, but such images as to content have been classed under people, because it was quite evident that the person or persons were the real centers of interest. That FF. is a close observer, as her mother says, is evident from the presence of details in her images which most persons would not have noticed in examining the particular object visualized, as for example, the way in which the sunlight fell upon certain parts of a dress, was reproduced in them.

A comparison of FF.'s images with those of her brother LF. shows that her visualizations are much more personal and in general less valuable as regards content. LF. for example visualized Lake Michigan, an aeroplane at the Exposition, the plains in New Mexico, scenes described in a book on the south pole, speed boats at the Exposition, views of Pittsburgh, a glacier, picture of Whistler, harbor at Sandusky, etc. FF. Gertrude Jones on her wheel, Mrs. Jordan at a picture, Dr. Lane shooting at little cans, Mrs. Ely with a rose in her hair singing, etc. As FF. is an intelligent girl, it is probable that the unimportant content of her images is due to her secluded education and the greater emphasis laid by those who have had to do with it on the less important matters of life. What is true of the content of FF.'s images is also true of the images of the other girls who took part in the experiments.

The results with FF. show very clearly the diagnostic significance of these experiments from an educational standpoint. FF.'s mother, with whom I studied the results, I found later, had made an application of what she had learned. FF.'s reading had been altered and family discussions were now more often connected with matters of world interest.

The results also show that *visual images reveal the attitude of an individual as regards the world around him.* The activities pictured in the image and the observer's relation to such activities show whether he is a participator, an actor in the scene, or only an observer of it, that is, whether an objective or subjective attitude of mind marks him.

Before leaving the discussion of the general facts it ought to be said, perhaps, that the results do not show that a study of a person's visual images alone, even where such images are very strong and detailed, will *completely* represent his personality. To obtain such a representation, as well as to determine the laws of thought in general, not only must the content of other images, as the tactile, auditory and kinesthetic, be studied in themselves and in a comparative way but the relative signif-

icance of each kind of imagery in the observer's life should be investigated. His imageless thought should also be examined. Taine, in saying that the laws of thought can be determined by studying images, was only correct in the main. There is, as I have previously shown, some of our thinking which is not represented by images, even in case of those having a strong visual memory which is actually measurable and this *unanschaulich* residue must not, of course, be neglected in a complete investigation of personality.

Where an observer does not have visual images other images could doubtless be similarly employed, but where he has fairly strong visual images their use is to be preferred, in that an observer is instructed to examine a thing having a reality and objectivity comparable with that of a positive and negative after-image, where the possibility of measurement is universally admitted. What I mean to say is that in examining visual images a reagent's observing powers are called into play as they would be in making a study of a sensory object and the demands made upon his introspective powers are therefore much less than in examining other images and imageless thinking.

The results of another series of experiments where the observer was instructed to arouse, respectively, let arise, a feeling image or experience, showed that not alone the sensory image, but also the feeling image or experience method, should be employed, as in some observers emotion plays so important a rôle as even, for example, to transform major image centers into minor and vice versa. Not alone as a matter of confirmation and supplementation should the feeling image method be used, but to obtain information concerning the energizing and non-energizing effect of emotion as regards thinking and acting.

Supplementation and modification of the series just outlined would be desirable as, for example, the effect on imagery of shifting the environment systematically, or, again, experiments in which the experimenter suggested the subjects of the images would be useful in showing the initiative imaging and thinking power of an observer. In reading a piece of poetry or prose, one is often able to represent what is presented, but is painfully aware that he has not sufficient intellectual initiative power in the particular direction to have had the images and ideas arise spontaneously.

The tabulations show further that

Memory images predominate in the visualization of the observers.

Certain subjects are more likely to be reproduced in the form of imagination images by some observers than others.

Memory images are usually definitely located as to the time of the corresponding experience.

The shorter the time since an experience occurred, the greater the probability of its being visualized.

The probability of the visualization of a more recent experience does not decrease with the age of the observer, as might have been expected from Ribot's investigations.

The observer's present environment is often determinative as regards the images which arise.

Certain places, objects and activities are more likely to be visualized.

While the range of visualization as regards time, place and subjects, differs with different observers, it is in general constant in case of the same observer.

The range of visualization as regards the amount included in the image differs.

Previously connected experiences are evidently not as closely bound together above

and below the threshold of consciousness in case of some of the observers as of others.

The time taken for the arising of spontaneous and willed images varies greatly in the same and different observers.

With some observers the preimage, that is, subconscious mental activity, is much more frequent and has much more influence as regards the kind of willed image that arises.

Subconscious activity is sometimes revealed in the willed images that arise.

The spontaneous images give a survey of the static and dynamic condition of the subconscious.

The following is a brief summarization of some other matters of practical and theoretical interest brought out by the examination of the experimental results: It is possible through using the image method, to determine the richness and poverty of the subconscious in a given individual as regards quality and quantity; his tendency to react along the lines of habit-thought (spontaneous ideas and images); whether he has naturally or has acquired the ability to direct the course of his thought, in short, whether he is really able to free himself from habit-thoughts and start new lines of thinking; to ascertain how to enrich or render non-effective, when desirable, what is subconscious in an individual; to foretell the probable effect of a given environment, as regards momentary thinking and the storing up of thought material upon a particular observer and upon observers in general, and the length of residence most desirable as regards such storing up; again, the prevailing thought-constellations in a given observer can be ascertained through the method as well as whether it is possible and desirable to strengthen such natural groupings or to break them up through education; whether the levels and strata of the subconscious in a given observer can and should be shifted; also, whether marked vacillations of attention in a person are not sometimes due to persistent preimages and if so whether it is not possible for such images to be excluded or transformed into more useful forms; again, whether work may not sometimes be more rapidly and effectively done by an observer by letting himself go and waiting for the problem to solve itself under the threshold of consciousness and spring into consciousness, that is, whether too much or too little emphasis is being laid on will in his case; to make out whether permanency or vacillation characterizes a person's thinking and the effect of this on his life as an actor; to get at the strength of will of an observer and to determine the possibility of weakening or strengthening it; to determine the direction and strength of a reagent's memory and imaginative power for the purpose of getting information concerning his ability and weakness along observational lines and correcting them where desirable; to decide whether it is better to let one's subconscious thinking take care of itself or to make an effort to educate it; to examine the effect of weariness and sickness on an individual's intellectual life, as it is possible that these are not entirely detrimental from the standpoint of the storing up and destruction of thought material; to get hints regarding a reagent's fitness for a given vocation; in short, to make a diagnostic, prophylactic, and therapeutic study of the consciousness of a given individual.

In examining the work being done to-day along the line of mental tests my criticism has been that nearly everywhere it seems to end in the diagnosis, that is, the therapeutic significance of what is learned from the diagnosis is too much ignored. For this reason I have asked myself and have made some experiments to ascertain what the image method had to offer in a therapeutic

way. My preliminary experiments show that where persistent images are found, as in the various forms of hallucinations of normal persons, or persistent ideas as in the incipient forms of delusions, one can break them up and ultimately destroy them in some cases and in others substitute for them images and ideas having a more agreeable nature. The breaking down and destructive process was actually accomplished in cases of apparitions, accounts of which I have already published. I am now working upon experiments having to do not so much with the possibility of supplanting spontaneous images having a disturbing character by those that are more agreeable, for that I now know is possible, but more particularly with the various modes of bringing it about. I can already see that the photograph, stereopticon views, the moving picture and its accessories appealing to the other senses and the phonograph will be very useful in the building up and supplanting process just mentioned.

Before suggesting a new method of studying personality one naturally employs other methods to test and control his own. Biographical, autobiographical, historical, observational, introspective, etc., methods have actually been employed in the course of these experiments, in that the opinion that images are betrayers of personality is based, as has been said, upon the general agreement between what the images reveal regarding the observer and what others, including myself, know of him and of what he himself said regarding their revealing power.

It is everywhere evident that the more impersonal, systematic, and exact observation and introspection employed in the image method, give more reliable information regarding an individual than the chance and uncontrolled observation and introspection used in the methods just mentioned. Again, the observer's powers of discrimination in employing the image method are not called upon to the extent they would be if he was asked to make a series of judgments upon his own characteristics, since he was not informed until the experiments were completed as to the object of the investigation. What was learned by the image method was much more intimate and detailed than by the others. The experiments yielded not alone information agreeing with what was previously known of the observer by others and by myself, but what was not even known to the observers themselves until after the investigation had been made, that is, the images actually brought characteristic reactions to the observers' attention which they had not noticed before.

As it is in the association methods that one would expect to find the image method competitors, I determined to make some direct tests and asked each of the observers who took part in these experiments to write one hundred words in succession. The words written show that very much more can be learned through using the image method. The same thing was shown in applying the Kent-Rosanoff associative method.

It may be said in a general way regarding all the association methods, and among these I include the methods of psychoanalysis, that the image method gives results as regards personality that are far more definite and clear cut.

The experiments of Ach and Barrett along the lines of temperament and character mark an important step in experimental psychology, and it would be very interesting to compare results obtained by applying their methods and material with those obtained by the image method. However, the confining of character study largely to data having to do with choice,

and choice in connection with such very simple material as they used, is much too limited to give an adequate idea of an observer's personality, and for this reason, unless the experimental material were enormously increased and the method so modified as to introduce other mental activities than will, I am confident the use of this method also, as regards the image method, would be one of control and support and perhaps of supplementation. Taken all in all, it seems to me, the image method is more information bringing than any of other methods which have been proposed.

In the way of a general summary and conclusion it may be said that the results everywhere show that images are not isolated entities, but are closely bound together, supporting and supplementing each other as information-bearers and that for this reason one gets through taking them apparently at random, typical examples of the entire range of an individual's imagery. Since images are in general the "high-points" of *unanschaulich* thinking, one may also obtain from them a very complete idea of an individual's general manner of thinking and acting. Stated briefly, the experiments show that the image method is a mode of "sampling" which is adequate for a satisfactory diagnosis of a personality.

Lillien J. Martin
Stanford University

THE INDUSTRIAL FELLOWSHIPS OF THE MELLON INSTITUTE[1]

It is again my privilege to report to Science progressive growth in both the number of industrial fellowships in operation and the amounts subscribed for their support. This makes evident the confidence which industrialists have in the Mellon Institute and the genuine value to industry of the industrial fellowship system.

The following table presents the number of industrial fellowships which have been established at the Mellon Institute from March to March of each year, 1911 to 1917; the number of researchers, or industrial fellows, who have been employed thereon, and the total amounts of money contributed for their maintenance by the industrial fellowship donors.

March to March	Number of Industrial Fellowships	Number of Industrial Fellows	Amounts Contributed
1911–1912..	11	24	$ 39,700
1912–1913..	16	30	54,300
1913–1914..	21	37	78,400
1914–1915..	21	32	61,200
1915–1916..	36	63	126,800
1916–1917..	42	64	147,000

As indicated in last year's report,[2] when the industrial fellowship system passed out of its experimental stage—when the Mellon Institute occupied its permanent home in February, 1915—twenty-three fellowships were in operation, while on March 1, 1916, there were thirty-six fellowships. It was mentioned in that report that the growth of the institute had about reached the stage where we should be obliged to decline further industrial investigations temporarily, since our laboratories were almost filled up to capacity. Notwithstanding that fact, the impetus imparted to the investigational activity in American chemical manufacturing, the direct result of the appreciation of urgent action in industrial research, induced us to arrange for the acceptance of six new fellowships during the institute year, March 1, 1916, to March 1, 1917. At the present time (March 1, 1917) there are forty-two fellowships and four additional ones have recently been arranged for, to begin later in the year.

[1] For previous reports on the status of the system of cooperation between science and industry in operation at the Mellon Institute, see Duncan, Science, N. S., Vol. XXXIX. (1914), 672; and Bacon, *ibid.*, XLIII. (1916), 453.

[2] Science, N. S., Vol. XLIII. (1916), 453.

A LIST OF THE INDUSTRIAL FELLOWSHIPS IN OPERATION AT THE MELLON INSTITUTE ON MARCH 1, 1917

Numbers and Names of Industrial Fellowships in Operation	Industrial Fellows, Names and Degrees	Foundation Sums and Dates of Expiration
No. 28. *Fertilizer*	H. H. Meyers (B.S., University of Pennsylvania).	$2,500 a year for 1 year. Bonus: $5,000. January 5, 1918.
No. 48. *Bread*	*H. A. Kohman* (Ph.D., University of Kansas), Senior Fellow. T. M. Godfrey (B.S., University of Kansas). L. H. Ashe (B.S., University of Pittsburgh).	$6,500 a year for 2 years. Bonus: $10,000. March 1, 1917.
No. 51. *Yeast*	*Ruth Glasgow* (M.S., University of Illinois). T. A. Frazier (Chem.B., University of Pittsburgh).	$3,150 a year for 2 years. September 1, 1917.
No. 61. *Synthetic organic products*	*C. S. Palmer* (Ph.D., Johns Hopkins University), Senior Fellow. W. J. Harper (A.B., Ohio University). E. W. Reid (A.B., Southwestern College).	$6,000 a year for 2 years. Bonus: $3,500. November 10, 1917.
No. 63. *Canning*	E. H. Taylor (M.S., University of Illinois).	$1,200 a year for 1 year. November 1, 1917.
No. 67. *Bottle glass*	J. F. W. Schulze (Ph.D., Clark University).	$2,400 a year for 1 year. September 1, 1917.
No. 68. *Illuminating glass*	A. H. Stewart (A.B., Washington and Jefferson College).	$900 a year for 2 years. October 1, 1917.
No. 74. *Dental products*	C. C. Vogt (Ph. D., Ohio State University).	$2,300 a year for 1 year. July 1, 1917.
No. 76. *Glue and soap*	F. O. Amon (Sc.D., New York University). B. H. Nicolet (Ph.D., Yale University), Advisory Fellow.	$4,000 a year for 1 year. December 20, 1917.
No. 77. *Food container*	C. L. Weirich (M.S., University of Pittsburgh)..	$1,800 a year for 1 year. Bonus: $6,000. March 31, 1917.
No. 78. *Iron ore*	F. M. McClenahan (M.A., Yale University).	$3,000 a year for 1 year. June 15, 1917.
No. 79. *Sand*	S. C. Ells (B.Sc., McGill University).	$5,000 a year for 1 year. June 1, 1917.
No. 82. *Medicinal products*	O. F. Hedenburg (Ph.D., University of Chicago).	$2,500 a year for 1 year. Bonus: 1 per cent. of profit for 5 years. June 14, 1917.
No. 84. *Copper*	H. P. Corliss (Ph.D., University of Pittsburgh). C. L. Perkins (B.S., New Hampshire College).	$5,400 a year for 1 year. July 1, 1917.
No. 85. *Copper*	E. D. Wilson (Ph.D., University of Chicago). A. S. Crossfield (B.S., University of California).	$3,600 a year for 1 year. July 1, 1917.
No. 86. *Pharmaceutical products*	*J. B. Churchill* (M.S., Pennsylvania State College), Senior Fellow. C. J. Herrly (B.S., Pennsylvania State College).	$4,600 a year for 1 year. July 7, 1917.
No. 87. *Washer waste*	C. B. Carter (Ph.D., University of North Carolina).	$2,500 a year for 1 year. August 7, 1917.
No. 88. *Soda*	C. W. Clark (Ph.D., University of Pittsburgh).	$3,000 a year for 1 year. September 1, 1917.
No. 89. *Organic synthesis*	H. A. Morton (Ph.D., University of Pittsburgh). H. J. Little (B.S., Delaware College).	$3,600 a year for 1 year. Bonus: $5,000. July 1, 1917.

(*Continued*)

Numbers and Names of Industrial Fellowships in Operation	Industrial Fellows, Names and Degrees	Foundation Sums and Dates of Expiration
No. 90. *Gas*	*J. B. Garner* (Ph.D., University of Chicago), Senior Fellow. F. W. Padgett (M.S., University of Pittsburgh). C. A. Neusbaum (A.B., Wabash College). D. F. Zimmers (B.S., University of Pittsburgh), Scholar.	$9,420 a year for 1 year. September 15, 1917.
No. 91. *Coke*	*F. W. Sperr, Jr.* (B.A., Ohio State University), Advisory Fellow. Marc Darrin (M.S., University of Washington). A. A. Kohr (B.S., Ohio State University). R. J. Montgomery (Cer. Eng., Ohio State University).	$5,640 a year for 1 year. January 1, 1918.
No. 93. *Collars*	H. D. Clayton (B.A., Ohio State University).	$2,300 a year for 1 year. October 1, 1917.
No. 94. *Coffee*	C. W. Trigg (B.S., University of Pittsburgh).	$1,500 a year for 1 year. Bonus: 2 per cent. of gross receipts. October 1, 1917.
No. 95. *Magnesia*	G. F. Gray (M.E. in E.E., Ohio State University).	$3,500 a year for 1 year. November 1, 1917.
No. 96. *Machinery*	Rudolph McDermet (E.E., University of Illinois).	$2,000 a year for 1 year. September 1, 1917.
No. 97. *Oil*	*B. T. Brooks* (Ph.D., University of Göttingen), Senior Fellow. Harry Essex (Ph.D., University of Göttingen). I. W. Humphrey (M.S., University of Kansas). D. F. Smith (M.S., University of Wisconsin).	$10,000 a year for 1 year. Bonus: $10,000. September 1, 1917.
No. 98. *Paints*	J. V. Thompson (A.B., Cornell University). C. E. Ruby (B.S., University of Kentucky).	$2,100 a year for 1 year. September 1, 1917.
No. 99. *Glyceryl phosphates*	F. F. Rupert (Ph.D., Massachusetts Institute of Technology).	$1,500 a year for 1 year. Bonus: 10 per cent. of profits. October 1, 1917.
No. 100. *Fiber*	C. E. Howson (B.S., Ohio State University).	$2,500 a year for 1 year. November 13, 1917.
No. 101. *Milling*	H. C. Holden (M.S., New Hampshire College).	$2,500 a year for 1 year. October 18, 1917.
No. 102. *Fruit juice*	R. R. Shively (Ph.D., University of Pittsburgh).	$5,000 a year for 1 year. October 1, 1917.
No. 103. *By-products recovery.*	Walther Riddle (Ph.D., University of Heidelberg).	$3,000 a year for 1 year. January 1, 1918.
No. 104. *Copper*	*G. A. Bragg* (B.S., University of Kansas), Senior Fellow of all *Copper* Fellowships. J. D. Malcolmson (B.S., University of Kansas).	$6,500 a year for 1 year. November 1, 1917.
No. 105. *Illumination*	*G. O. Curme, Jr.* (Ph.D., University of Chicago), Senior Fellow. G. D. Bagley (M.S. in E.E., University of Illinois). H. R. Curme (B.S., Northwestern University). C. N. Iry (B.S., Purdue University).	$8,000 a year for 1 year. Bonus: $5,000. November 15, 1917.

(*Concluded*)

Numbers and Names of Industrial Fellowships in Operation	Industrial Fellows, Names and Degrees	Foundation Sums and Dates of Expiration
No. 106. *Silverware*	H. E. Peck (B.S., Clarkson Memorial College of Technology).	$2,000 a year for 1 year. December 11, 1917.
No. 107. *Cottonseed*	F. W. Stockton (A.B., University of Kansas).	$3,600 a year for 1 year. Bonus: $5,000. October 16, 1917.
No. 108. *Insecticides*	C. O. Brown (M.A., Cornell University).	$3,000 a year for 1 year. January 1, 1918.
No. 109. *Glass refractories*	A. E. Blake (M.S., University of Pittsburgh).	$2,300 a year for 1 year. November 1, 1917.
No. 110. *Toilet articles*	L. M. Liddle (Ph.D., Yale University).	$3,000 a year for 1 year. December 1, 1917.
No. 111. *Distillation*	David Drogin (B.A., College of the City of New York).	$1,800 a year for 1 year. January 18, 1918.
No. 112. *Laundering*	H. G. Elledge (M.S., University of Pittsburgh).	$2,500 a year for 1 year. February 15, 1918.
No. 113. *Flavoring*	W. E. Vawter (B.S., University of Kansas).	$1,800 a year for 1 year. Bonus: $2,000. February 1, 1918.
Special research work.	E. O. Rhodes (M.S., University of Kansas) and R. W. Miller (M. S., Kansas State College).	

SUBJECT LIST OF INDUSTRIAL FELLOWSHIPS FROM THE INAUGURATION OF THE SYSTEM TO THE PRESENT TIME

University of Kansas, 1907–1911[8]

K–1. Laundering. K–2. Alfalfa. K–3. Salt-rising Bread. K–4. Casein. K–5. Oil. K–6. Enamel. K–7. Glass. K–8. Cement. K–9. Varnish. K–10. Borax. K–11. Adrenaline. K–12. Vegetable Ivory. K–13. Oil. K–14. Gilsonite. K–15. Fats. K–16. Leather. K–17. Copper. K–18. Copper (continuation of K–17).

University of Pittsburgh, 1911 to date

1. Bread. 2. Smoke. 3. Glass. 4. Bread. 5. Glue. 6. Soap. 7. Fruit Juice. 8. Composition Flooring. 9. Oil. 10. Gas. 11. Cement. 12. Foods. 13. Fatty Oils. 14. Electricity. 15. Coated Steel. 16. Copper (continuation of K–18). 17. Desert Plant. 18. Bread (continuation of 4). 19. Aluminum. 20. Glue (continuation of 5). 21. Soap (continuation of 6). 22. Glass. 23. Electricity (continuation of 14). 24. Copper (continuation of 16). 25. Yeast. 26. Fats (continuation of K–15). 27. Leather Waste (continuation of K–16). 28. Fertilizer. 29. Copper (continuation of 24). 30. Radiators. 31. Machinery. 32. Glass. 33. Copper (continuation of 29). 34. Fatty Oils (continuation of 13). 35. Copper (continuation of 33). 36. Copper. 37. Illumination. 38. Dental Products. 39. Compound Fats. 40. Stone. 41. Copper (continuation of 35). 42. Bottle Glass. 43. Laundering. 44. Land Development. 45. Copper (continuation of 35). 46. Organic Synthesis. 47. Soda. 48. Bread (continuation of 18). 49. Candy. 50. Paints. 51. Yeast (continuation of 25). 52. Copper (continuation of 36).

[8] The system of industrial research founded by

Subject List of Industrial Fellowships from the Inauguration of the System to the Present Time (continued)

53. Copper (continuation of 45). 54. Dental Products (continuation of 38). 55. Pharmaceutical Products. 56. Soap (continuation of 21). 57. Glue (continuation of 20). 58. Machinery (continuation of 31). 59. Milling. 60. Collars. 61. Inorganic Synthetic Products. 62. Gas. 63. Canning. 64. Oil (continuation of 9). 65. Compound Fats (continuation of 39). 66. Glyceryl Phosphates. 67. Bottle Glass (continuation of 42). 68. Glass (continuation of 22). 69. Linoleum. 70. Gum. 71. Stoves. 72. Copper (continuation of 53). 73. Illumination (continuation of 37). 74. Dental Products (continuation of 54). 75. Flavoring Materials. 76. Glue and Soap (continuation of 56 and 57). 77. Food Container. 78. Iron Ore. 79. Sand. 80. Laundering (continuation of 43). 81. Varnish. 82. Medicinal Products. 83. Cannel Coal. 84. Copper (continuation

of 52). 85. Copper (continuation of 72). 86. Pharmaceutical Products (continuation of 55). 87. Washer Waste. 88. Soda (continuation of 47). 90. Gas (continuation of 62). 91. Coke. 92. Leather Belting. 93. Collars (continuation of 60). 94. Coffee. 95. Magnesia. 96. Machinery (continuation of 58). 97. Oil (continuation of 64). 98. Paints (continuation of 50). 99. Glyceryl Phosphates (continuation of 66). 100. Fiber. 101. Milling (continuation of 59). 102. Fruit Juice. 103. By-products Recovery. 104. Copper (continuation of 85). 105. Illumination (continuation of 73). 106. Silverware. 107. Cottonseed. 108. Insecticides. 109. Refractories (Glass). 110. Toilet Articles. 111. Distillation. 112. Laundering (continuation of 80). 113. Flavoring (continuation of 75). 114. Enameling. 115. Bread (continuation of 48).

The Mellon Institute is now active in promoting the progress of science and in stimulating further inquiry by making available to the workers in pure and applied science complete and detailed reports of researches conducted under its auspices;[4] it maintains an attitude of welcome towards prospective industrial research organization[5] and has established stable cooperative relations with other research laboratories; and it is continuing its policy of educating the public to the realizable functions of research.[6] While effectively combatting pseudo-research in industry by reducing the cost of systematic investigation to a minimum, the Mellon Institute has been able to demonstrate to industrialists that, under favorable conditions, numerous manufacturing problems can be advantageously studied outside of plant laboratories. This has resulted in the extension of the practise of referring certain of the problems of industry to university laboratories for study.[7] However, this cooperative relation must be stabilized and promoted by the demonstration of its advantages by the institutional laboratories involved. About seventy per cent. of the problems assigned to the Mellon Institute for study during the five years, March, 1911, to March, 1916, were solved to the satisfaction of the donors, and like results can undoubtedly be obtained by similarly well-founded establishments. On every side the research men of our universities are needed for the execution of real attainment in the technical world with its difficulties, wastes and unexplored lines of manufacturing.

The administration of the Mellon Institute is now constituted as follows:

Raymond F. Bacon, Ph.D., Director;
Edward R. Weidlein, M.A., Associate Director;
Samuel R. Scholes, Ph.D., Assistant Director;
E. Ward Tillotson, Jr., Ph.D., Assistant Director;
John J. O'Connor, Jr., M.A., Assistant Director;
Martin A. Rosanoff, Sc.D., Head of the Department of Research in Pure Chemistry.

R. F. Bacon

Pittsburgh, Pa.,
March 1, 1917

[4] Twenty-two journal contributions were made during the past Institute year. For a list of the scientific papers published by the Institute from 1911–1914, see Bacon, *J. Frankl. Inst.*, November, 1914, 629–32. Eighteen journal articles were published by the Institute during 1914–1915 (Sparks and Noyes, Science, N. S., Vol. XLV. (1917), 169).

[5] The following institutions have entered the field of industrial research: the universities of Kansas, Washington, Toronto and Akron, the Georgia School of Technology and the University of Finland (Helsingfors, Finland). The establishment of industrial fellowships in accordance with the practical system in operation at the Mellon Institute, is being considered by Massachusetts Agricultural College, Harvard University, Washington State College, McGill University, University of Sheffield (England), Sir John Cass Technical Institute (London), Sydney University (New South Wales, Australia), and University of Tokyo (Japan).

[6] See, in this connection, Bacon, Science, N. S., Vol. XLV. (1917), 34.

[7] For detailed presentments of the present-day technochemical problems which could be referred to university laboratories for investigation, see Bacon, *J. Ind. Eng. Chem.*, 7 (1915), 535; and *J. Soc. Chem. Ind.*, 36 (1917), 9.

SCIENTIFIC EVENTS

GRANTS FOR SCIENTIFIC AND INDUSTRIAL RESEARCH IN ENGLAND

When the establishment of a separate department of scientific and industrial research was announced in December last, Lord Crewe

stated that the chancellor of the exchequer was prepared to advise the government to devote a sufficient sum to cover operations during the next five years on a scale which would provide four, or perhaps five, times as much for cooperative industrial research as had been spent for the whole purposes of research hitherto. According to *Nature* the civil service estimates just issued include the sum of £1,038,050 to the Department of Scientific and Industrial Research, being a net increase of £998,050 upon last year's amount. Grants for investigations carried out by learned and scientific societies, etc., are estimated at £24,000, and grants to students and other persons engaged in research at £6,000. These grants will be distributed by a committee of the Privy Council, on the recommendation of the Advisory Council, to promote the development of scientific and industrial research in the United Kingdom, and will be subject to such conditions as the committee may think necessary. The £1,000,000 grant in aid of industrial research will be paid to the account of the Imperial Trust for the encouragement of scientific and industrial research. The expenditure of the trust will be audited by the comptroller and auditor-general, but any balance remaining on the account will not be surrendered at the close of the financial year. Grants will be made by the directions of the committee of the Privy Council over an agreed period to approved trade associations for research, to supplement the funds of the associations, and payments in respect of such grants will not be liable to surrender by the grantees at the end of the financial year. It is understood from Lord Crewe's remarks on December 1 that for the next five years or so about £200,000 a year would be available for scientific and industrial research, so that apparently the grant of £1,000,000 is the sum which is to be drawn upon for this purpose. The amount estimated for salaries, wages and allowances in the new department is £7,250, which includes £1,500 for the secretary and £850 for the assistant secretary. Traveling and incidental expenses are estimated to amount to £860.

THE GENERAL MEDICAL BOARD OF THE COUNCIL OF NATIONAL DEFENSE

A general medical board of the Council of National Defense was organized on April 17 at a meeting attended by leading physicians from all parts of the country. The board is to have general supervision of the mobilization of the nation's medical resources during the war. Dr. Franklin Martin, of Chicago, will be chairman of the board, which will also include the leading members of the executive committee of the board, announced a short time ago. The list follows:

Dr. Franklin Martin, chairman.

Dr. F. F. Simpson, vice-chairman.

Surgeon General William C. Gorgas, United States Army.

Surgeon General William C. Braisted, United States Navy.

Surgeon General Rupert Blue, United States Public Health Service.

Colonel Jefferson R. Kean, director of military relief, American Red Cross.

Dr. William H. Welch, professor of pathology, Johns Hopkins University.

Dr. William J. Mayo, Rochester, Minn.

Dr. Edward Martin, professor of surgery, University of Pennsylvania.

Dr. Victor C. Vaughan, dean of the medical school of the University of Michigan.

Dr. George H. Simmons, editor, *Journal of American Medical Association,* Chicago.

Dr. Richard P. Strong, professor of tropical medicine, Harvard University.

Dr. Joseph M. Flint, professor of surgery, Yale University.

Dr. Stuart McGuire, professor of surgery, University of Virginia.

Dr. John Young Brown, professor of surgery, University of St. Louis.

Dr. Charles H. Mayo, Rochester, Minn.

Dr. Thomas W. Huntington, professor of surgery, University of California.

Dr. Hubert A. Royster, secretary of Southern Surgical Association.

Dr. Charles H. Peck, professor of surgery, Columbia University.

Dr. Winford Smith, superintendent, Johns Hopkins Hospital.

Dr. Frederic A. Besley, professor of surgery, Northwestern University.

Dr. George W. Crile, professor of surgery, Western Reserve University.

Earl Phelps, sanitary engineer, Washington, D. C.

Dr. John M. Finney, professor of clinical surgery, Johns Hopkins University.

Dr. Edward P. Davis, professor of obstetrics, Jefferson Medical College.

Dr. Edward C. Kirk, dean of dental department, University of Pennsylvania.

Dr. W. C. Woodward, commissioner of Public Health, Washington, D. C.

Dr. Simon Flexner, director, Rockefeller Institute, New York City.

Dr. Theodore Janeway, professor of medicine, Johns Hopkins University.

Dr. Hermann M. Biggs, New York Commissioner of Public Health.

Dr. George Brewer, professor of surgery, Columbia University.

Dr. George Walker, Johns Hopkins University.

SCIENTIFIC NOTES AND NEWS

At the meeting of the National Academy of Sciences in Washington on April 18, the following members were elected: Edward Kasner, mathematics; Walter S. Adams, astronomy; Theodore Lyman, Walter C. Sabine, S. W. Stratton, physics; W. R. Whitney, chemistry; J. J. Carty, electrical engineering; W. F. Durand, marine engineering; H. M. Howe, metallurgy; E. O. Ulrich, geology; Robert Ridgway, ornithology; Harvey Cushing, William S. Halsted, surgery; L. H. Bailey, botany; Edward L. Thorndike, psychology.

At the annual dinner of the National Academy of Sciences on the evening of April 17, the Henry Draper gold medal was presented to Professor A. A. Michelson, of the University of Chicago, and the public welfare medal to Dr. S. W. Stratton, director of the Bureau of Standards.

The seventh annual award of the Willard Gibbs Medal, founded by William A. Converse of Chicago, will be made to Dr. Edward W. Morley. Dr. Morley was elected by a jury of twelve, including some of our most eminent chemists in the United States. He will talk upon his early work in connection with hydrogen and oxygen, on Friday evening, May 18, at Hotel Sherman, Chicago, at which meeting the medal will be awarded to him. Previous recipients of this medal have been: W. R. Whitney, A. A. Noyes, T. W. Richards, Ira Remsen, L. H. Baekeland and Svante Arrhenius.

Professor M. C. Whitaker, head of the department of chemical engineering, Columbia University, was elected vice-president of the U. S. Industrial Alcohol Co., at the meeting of their board, on April 19. In this capacity, Mr. Whitaker will serve as chairman of the manufacturing committee in charge of plants and operations, chairman of the research committee in charge of the new laboratories at Baltimore, and as a member of the sales committee of the company.

Dr. H. N. McCoy, who has been connected with the department of chemistry of the University of Chicago since 1901 and professor since 1911, has tendered his resignation in order to be free to devote more time to his important technical interests. His process of extracting radium from carnotite is being used by the Carnotite Production Company of Chicago in which he is a director. He is also interested in the production of thorium and related products and is a director of the Lindsay Light Company of Chicago, which has probably the largest thorium production in the country.

Anouncement is made by the Forest Service of the appointment of Carlile P. Winslow as director of the Forest Products Laboratory, at Madison, Wisconsin, to succeed Howard F. Weiss, whose resignation took place on April 1.

Dorothy W. Block has been awarded the Maria Mitchell memorial scholarship of $500, to be used in research work at the Harvard observatory during the year 1917–18. For the past two years Miss Block has been laboratory assistant in the department of astronomy at Hunter College.

James F. Couch was elected president of the recently organized Des Moines Chemical Society at the regular meeting on April 9.

A graduate medical course will be conducted at the new St. Luke's Hospital, Spokane, during the summer. Among those who have accepted invitations to lecture, according to the *Journal* of the American Med-

ical Association, are: Drs. W. T. Councilman, Harvey Cushing, Walter B. Cannon, Fritz B. Talbot, James S. Stone, George Holmes, David L. Edsall and Francis W. Peabody, Boston; William G. MacCallum and Warfield T. Longcope, New York; Lewellys F. Barker and Theodore C. Janeway, Baltimore, and Rollin T. Woodyatt, Ludvig Hektoen and Harry G. Wells, Chicago.

The advisory commission of the Council of National Defense and the National Research Council have sent six American men of science to England and France to study problems arising out of the war. Members of the party and the subjects in which they will specialize are: Dr. Joseph S. Ames, Johns Hopkins University, aeronautical conditions; Dr. Richard P. Strong, Harvard University, camp sanitation; Dr. Linsley R. Williams, assistant health commissioner of New York State; George A. Hulett, Princeton University, chemistry of explosives; Dr. Harry Fielding Reid, Johns Hopkins University, scientific map making and photography from airplanes, and Dr. George R. Burgess, of the Federal Bureau of Standards, metals suitable for guns and rigid dirigibles. The party is accredited to the American Embassies in London and Paris.

Six professors of the University of Minnesota have been asked by the war department to act as a scientific research board for the district of the state of Minnesota. The duties asked of them will require a considerable portion of their time from now on. These men are Professor John J. Flather, head of the department of mechanical engineering, Dean George B. Frankforter of the school of chemistry, Dr. L. G. Rowntree, head of the department of medicine, Professor R. W. Thatcher, head of the department of agricultural chemistry, L. W. McKeehan of the department of physics, F. R. McMillan, of the department of structural engineering. Dean Frankforter and Professor Flather acted upon a special navy board which made an inventory of Minnesota resources last summer and the figures which they gathered at that time will be of inestimable value in the present crisis.

At the annual dinner and initiatory exercises of the Washington University chapter of Sigma Xi, the president of the chapter, Dr. B. M. Duggar, discussed "Some Materials and Problems in Plant Pathology."

Dr. Charles Baskerville, director of chemical laboratories of the College of the City of New York, delivered an illustrated address at the Franklin Institute, Philadelphia, on April 19, his subject being "The Hydrogenation of Oils."

At the recent meeting of the West Virginia Scientific Society Dr. Ludvig Hektoen, of the University of Chicago, delivered an address on "Recent Investigations of Infantile Paralysis."

Mr. William Bowie, chief of the division of geodesy, delivered recently an address before the Geological Society of Washington, D. C., on "Some Evidences of Isostasy."

Dr. R. A. Pearson, president of the Iowa State College, has been made chairman of a committee which will include one member from each congressional district of the state of Iowa and whose duty will be to organize the farmers of the state in the interest of food conservation and increased production. The creation of such a committee was recommended by a conference of the leading men of the state held at the state house on April 3 at the call of Governor Harding. The governor will appoint the other members of the committee. The conference recommended an emergency appropriation by the legislature of $100,000 for 1917 and an equal amount for 1918 to be used under the supervision of the extension department of the Iowa State College in a campaign to increase the food production of Iowa.

Professor A. D. Wilson, director of agricultural extension work of the University of Minnesota, has been appointed by the government to direct the work of farm production and labor conservation in the northwest during the continuance of the war.

Professor Joseph Jastrow, of the University of Wisconsin, is giving a series of lectures

at the Ohio State University on "Sources of Human Nature."

Herbert William Conn, professor of biology in Wesleyan University and Connecticut State bacteriologist, has died at the age of fifty-eight years.

The death is announced of Emil von Behring, professor in the University of Marburg, discoverer of diphtheria antitoxin. He was born in West Prussia in 1854. In 1901 he received the Nobed prize in medicine, and was made a member of the hereditary nobility.

The death is announced of Dr. Narcisse E. Dionne, librarian of the Legislature of Quebec, and formerly professor of archeology of Laval University. Dr. Dionne was the author of a number of important biographical and historical works, and in 1907 served as general secretary of the fifteenth International Congress of Americanists, which was held at Quebec.

The Southern Society for Philosophy and Psychology held its twelfth annual meeting on April 12 and 13, 1917, at Randolph-Macon Woman's College, Lynchburg, Va. It was voted to extend the scope of the society so as to include "experimental education," and to hold the next meeting at Peabody College for Teachers, Nashville, Tenn. The following officers were elected: President, Professor E. K. Strong, Jr., Peabody College, Nashville; Vice-president, Dr. T. V. Moore, Catholic University of America, Washington, D. C., and Secretary-Treasurer, Professor W. H. Chase, University of North Carolina. The newly elected members of the council are: Dr. Tom A. Williams, Washington, D. C., Professor E. B. Crooks, Randolph-Macon, Lynchburg, Va., and Professor Knight Dunlap, of Johns Hopkins University.

At the annual meeting of the American Association of Immunologists, held in New York, April 6 and 7, Dr. John A Kolmer, Philadelphia, was elected president; Dr. Martin J. Synnott, Montclair, N. J., secretary, and Dr. Willard J. Stone, Toledo, Ohio, treasurer. The new council is composed of the officers and Drs. Richard Weil, Arthur F. Coca and William H. Park, New York, and Dr. A. Parker Hitchens, Glen Olden, Pa. The next meeting will be held in Minneapolis in April, 1918.

A Science Faculty Club has been organized at the University of Southern California, Los Angeles, Calif. The purpose of the club is to promote research and cooperation between the departments of science in the university. A meeting is held each month. The officers are Professor Albert B. Ulrey, president; Professor Arthur W. Nye, vice-president, and Miss Catherine V. Beers, secretary.

The Oklahoma State Bureau of Standards, which was organized by act of the legislature of 1915 secured an appropriation of $8,500 with which to purchase equipment. It is the purpose of the bureau to secure primary and secondary standards of weights and measures and for testing gas, water and electric meters. The bureau is also planning the equipment of a laboratory for the measuring and testing of the best values of fuels as coal and petroleum products. The bureau is situated at the State University and with the equipment planned will be able to provide the people of the state a place where they may have their weights and meters, etc., calibrated.

UNIVERSITY AND EDUCATIONAL NEWS

The president of the Republic of Panama has signed a decree establishing a Pan-American University in accordance with a law passed by the legislature on January 27. The trustees are to consist of the secretary of public instruction of Panama and the diplomatic representatives of the American republics or their representatives. Diplomatic representatives of other countries maintaining chairs in the university are also to have representatives on the board. It is believed that the university may be of international value to the American republics, especially in subjects such as medicine, law and agriculture.

The legislature of the state of Oklahoma at its recent session made provision for the following buildings for the State University at Norman: Auditorium, $150,000; wing to library, $75,000; geology building, $100,000; hospital at Oklahoma City in connection with

the medical school, $200,000. At the same time the Agricultural and Mechanical Arts College at Stillwater was granted: Science hall, $100,000; gymnasium, $100,000.

THE residue of the estate of James Buchanan Brady, which is estimated as more than four million dollars, is bequeathed to the New York Hospital on West Sixteenth Street, New York City, to establish the James Buchanan Brady Foundation for a urological institute, similar to that at Johns Hopkins Hospital at Baltimore, which Mr. Brady had endowed during his life with $200,000. An additional $300,000 is left in trust to the Johns Hopkins Hospital for the maintenance of the institute.

THE Harvard Medical School will provide instruction for the senior class during the summer, with two weeks holiday. It is optional with students whether they will begin their fourth year's work on June 4 or September 24.

OWING to the national emergency, the Cornell University Medical College announces that it will continue instruction for members of its senior class throughout the summer so that they may be graduated with the degree of M.D. on or about January 1, 1917.

PROFESSOR C. R. RICHARDS, professor of mechanical engineering and head of the department since 1911, has been appointed dean of the College of Engineering and director of the Engineering Experiment Station of the University of Illinois to succeed Dr. W. F. M. Goss who has resigned to become president of the Railway Car Manufacturers' Association of New York.

DR. CHAS. BROOKOVER, of the University of Kansas, has been elected professor of anatomy and director of the department at the University of Louisville.

DISCUSSION AND CORRESPONDENCE

A VIABLE TEN-YEAR-OLD CULTURE OF BACILLUS PARATYPHOSUS BETA

As the usual text-books, manuals and current literature make but little or no mention of the length of life of individual bacteria the following record may not be without interest.

In 1909, when I began teaching bacteriology at Howard University, among the stock cultures of organisms in the laboratory was one labeled "Paratyphoid Schottmüller 1-14-06." It was a deep agar stab made in a narrow test tube and the tube instead of being closed in the usual manner by a cotton plug had been sealed off in the flame. Hermetically sealed, the agar culture had been prevented from drying. The culture had been prepared three years previously by Dr. W. W. Alleger.

On January 17, 1916, ten years and three days after the culture had been made, the tube was broken open and the organisms transferred to Russell double sugar. The characteristic red color and gas did not appear in the butt of the tube on the first transfer. Transfers were then made from this tube to other double sugar tubes at irregular intervals during a couple of months. At about the fifth transfer the organism showed its characteristic reaction on the double sugar. Its fermentation of separate sugars was tried, as well as other cultural tests, and the agglutination test with paratyphoid beta immune serum was done. All these indicated that the organism was *Bacillus paratyphosus beta*.

During the ten years it had always been kept in a closet away from the light, along with the other stock cultures. The temperature in closet varied during the first five years from as high as 32° C. in summer to nearly as low as 0° C. in winter. During the last five years the temperature was never lower than 15° C.

M. W. LYON, JR.
GEORGE WASHINGTON UNIVERSITY

A METHOD FOR KILLING TURTLES

KILLING turtles for class purposes is more or less of a task depending upon the equipment at hand. Even though a closed tank is available for administering gas, thirty minutes to an hour is required for anesthetizing these reptiles and then they may revive during dissection. Another expedient sometimes resorted to is to place the specimens in boiling water for a few minutes. This has its objections. I have observed attempts to

give an anesthetic or a poison by way of the mouth which is almost impossible. However, substances can be introduced into the alimentary tract through the anus and the desired results obtained.

Such is the method used in this laboratory. Chloroform is injected into the cloaca and a string tied in front of the anus to prevent the ejection of the liquid. Five c.c. of chloroform thus given will anesthetize an eight-inch turtle sufficiently for dissection in thirty to forty-five minutes.

The value of this method is threefold. First, a string and a pipette constitute the necessary equipment; second, the ease with which the anesthetic can be given is evident; and third, there is no danger of the specimens coming out from under the chloroform.

NEWTON MILLER
UNIVERSITY OF UTAH

SCIENTIFIC BOOKS

Combinatory Analysis. By MAJOR PERCY A. MACMAHON. Cambridge University Press. 1915, Vol. 1, xix + 300 pp., and 1916, Vol. 2, ix + 340 pp.

One of the four grand divisions of what may be called properly static mathematics is the theory of configurations. It includes the construction out of given elements of compound forms under certain given conditions or restrictions; together with the characters possessed by such constructions when they are varied under given laws, such as, for instance, the character of transitivity, or that of primitivity; and the laws of dependence of such constructions upon each other; as well as finally the invention of new or ideal elements of mathematics that enable the solution of problems of construction to be effected. These constructions vary from the mere permutation of a linear series of elements up to the complicated trees of chemical combinations studied by Cayley, and in general to all sorts of problems in what has been happily denominated tactics by Cayley, or syntactics by Cournot. We find in its field the construction of magic squares, of Latin squares, of Latin-Greek squares, of triangles, stars, polygons, chess problems, routes over net works, problems of topography, and without much stretch of imagination we might now include the disposition of the elements of war. The field is obviously large in extent, and in a wide variety of aspects fascinating. From certain points of view one might be tempted to conclude that we could include in it all mathematics, for the definition given by C. S. Peirce made mathematics the science of ideal constructions and their applicability to the world as it is.

The study of configurations usually begins with combinatory analysis. By this is usually meant the study of the arrangements along a line of a collection of objects, either as individuals or in groups; arrangements at the nodes of a lattice; combinations of arrangements. Such problems arise not only as matters of tactic, curious problems or puzzles, but in the determination of the number of such arrangements needed in solving problems in the theory of probabilities.

The treatise of Professor MacMahon undertakes to present some very general methods of handling such studies. These methods consist for a large part in the construction of enumerating generating functions, and involve considerable study of symmetric functions and certain differentiating operators. In the course of this study he arrives at some very elegant theorems. These methods not only enumerate the possible forms, but in many cases afford methods of actual construction of the entire list of such possible forms. They are very powerful and have enabled the author to solve problems that were considered for a long time to be beyond the reach of mathematical analysis. His success and presentation in complete form may induce others to study this important branch of mathematics.

There are eleven sections, and the topics under consideration will give some idea of the character of the treatise. Section one considers ordinary symmetric functions and their connection with the theory of distribution of objects into parcels. The operators which are useful for these purposes are developed, and their algebra considered, turning out to be quite analogous to the algebra of symmetric

functions. A distinction is drawn between the parcel of objects, in which the order of arrangement in the parcel is immaterial, and the group of objects, in which the order of arrangement in the group is material. For instance if we sort 3 α's 2 β's, 1 γ, 1 δ into seven boxes of which four boxes are exactly alike, and three boxes alike but different from the first four, we find that we have a problem of distribution of objects of type (321^2) into parcels of type (43), which can be done in 11 ways. This number 11 may be found by a distribution function, derived from the theory of symmetric functions. This function gives, for instance, for the various types of 4 objects distributed into parcels of type (2) these results: for type (4), 2 ways, for type (31) 3 ways, for type (22) 4 ways, for type (211) 5 ways, for type (1111) 7 ways. If, however, the distribution is into groups rather than into parcels, we have for type (4) 2 ways, for type (31) 6 ways, for type (22) 10 ways, for type (211) 18 ways, and for type (1111) 36 ways. The determination by the function consists in finding the coefficients in formulæ that arise from the theory of symmetric functions. These coefficients may be found directly for the individual terms by using the operators referred to.

Section two considers the theory of separations, a separation being a distribution of the numbers constituting a partition of some integer into parcels, or groups. Extensive generalizations are possible from the formulæ and the operators produced. The application to sets of objects of given types and their distributions resolves more complicated problems than those given before. For instance, with a set of four threefold objects, $a_1a_2a_3$, $a_1a_2a_3$, $b_1b_2b_3$, $c_1b_2c_3$ can be formed 38 cases of distribution into the types (211), (22), (211), namely the objects $a_1a_1b_1c_1$, $a_2a_2b_2b_2$, $a_3a_3b_3c_3$, and the different permutations of these arrangements.

Section three deals with permutations, particularly with points useful in the general theory of combinations and distributions. A certain master theorem is deduced which has great resolving power. In particular it solves the problem of ascertaining the number of permutations in which every letter occupies a new place, and in expressing sums of powers of binomial coefficients. The notion of lattice permutation is introduced, by which is meant that if any permutation be made of a α's. b β's, c γ's, etc., to be a lattice permutation it must be such that reading it from left to right, at no point of it will the number of α's so far written be less than the number of β's, nor number of β's less than the number of γ's, etc. For instance, for 2 α's and 2 β's the lattice permutations are $\alpha\alpha\beta\beta$, and $\alpha\beta\alpha\beta$. The permutation $\alpha\beta\beta\alpha$ is not a lattice permutation because when we arrive at the third letter, we shall have 2 β's and only 1 α. These are called lattice permutations because they serve to handle arrangements of integers at the nodes of a rectangular lattice in a plane, or in space.

Section four considers compositions of integers, by which is meant the permutations of the partitions of the integer. In connection with these some new symmetric functions are introduced. An application to Newcomb's problem is made. It is this: given p cards marked 1, q marked 2, r marked 3, etc., which are shuffled and dealt in such wise, that as long as a card is not of lower number than the preceding it is placed upon the preceding, but if lower it must start a new pile; what is the probability that there are at most m piles when all have been dealt?

Section five introduces the notion of perfect partition, that is partitions such that each contains only one partition of each lower number. For instance, for 7, a perfect partition is (4111), since we have only one partition of 1, 2, 3, 4, 5, 6. These are then applied to distributions upon a chess board. A connection is thus arrived at between magic squares and the general theory. The enumeration of Latin squares is effected by generating functions, thus solving a long-standing problem. For instance, the number of reduced Latin squares of order 1, is 1, of order 2, is 1, of order 3, is 1, of order 4, is 4, and of order 5, is 52.

Section six enumerates the partitions of multipartite numbers. A multipartite num-

ber is one that would be called in general algebra a multiplex, as (5, 3) or (3, 6, 2, 7).

Several tables of homogeneous functions, distribution functions, and enumerations close the first volume.

Section seven is devoted to the algebraic side of the partition of numbers, giving in some detail the present state of the theory, but omitting the purely arithmetic side. There are given here further developments connected with symmetric functions.

Section eight considers the theory of partitions as based upon Diophantine inequalities, generalizing the whole treatment. A chapter is devoted to the further study by this means of magic squares, the object being their enumeration rather than construction.

Sections nine and ten study partitions in two dimensions, including a complete solution of another long-standing problem. The problem of three-dimensional partitions relating to a cubic lattice is also attacked.

Section eleven relates to symmetric functions of several systems of quantities with applications to distribution functions.

The second volume closes with tables of symmetric functions of two systems, and enumeration of solid graphs.

If one were to undertake to characterize the treatise of Professor MacMahon briefly he would probably best state its field by saying that it is a development of the algebra of symmetric functions with applicatin to various generating expressions whose coefficients find use in enumeration problems of distribution. Professor MacMahon has occupied himself with the development of this theory for some years and the treatise is a systematic presentation of his results. No brief account can be given of the very skilful methods employed. It shows amply that alongside of the alternating functions so long studied in determinant forms, the symmetric functions are equally important and have their field of application. It exemplifies how different branches of mathematics can be correlated so as to be useful in reducing problems. It also draws strongly attention to the fact that there still remains in the field of algebraic form plenty of opportunity for the interested student to do research work of high order. Indeed it would seem that courses on symmetric functions at least should be offered alongside of other courses in algebra, such as theory of equations, determinants, groups, and the like. The whole theory of the construction of algebraic forms for certain specific purposes has been enriched here with a valuable contribution.

James Byrnie Shaw

SPECIAL ARTICLES

INHERITANCE OF OIL IN COTTON

The table of oil percentages given below suggests the possibility of producing divergent strains or biotypes from a "variety" of cotton, the one having seeds relatively high in oil content, the other relatively low in oil content.

The top line of figures gives the analysis (ether extract) of the seed from several mother plants, followed in column by the analysis of the seed of three of their progeny plants, respectively.

	17.33	20.64	16.58	18.97	16.79	18.92	
Progeny.....	18.21	22.00	17.16	22.10	17.75	19.37	18.47
	18.67	20.82	18.40	21.17	17.86	19.45	18.92
	19.13	21.06	17.86	21.36	17.52	19.19	18.40

The three "high" parents have an average of 19.51 per cent. oil, and their nine progeny plants an average of 20.72 per cent. oil.

The four "low" parents have an average of 16.89 per cent. oil, and their twelve progeny plants an average of 18.20 per cent. oil.

The maximum difference between parents is 4.06 per cent. oil, and the maximum difference between plants of the progeny generation is 4.94 per cent. oil.

A seasonal variation raising the oil content of all plants in the progeny year is noted.

A later report will give the correlation between oil content of the seed and other characters.

E. P. Humbert
Agricultural Experiment Station,
College Station, Texas

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION D—MECHANICAL SCIENCE AND ENGINEERING. II

Recent Developments in Details of Construction of Brick Pavements on Green Concrete Foundation and Sand-Cement Superfoundation: WILLIAM C. PERKINS.

Discussion of new methods of constructing brick pavements. Two methods of construction: (1) The laying of the brick directly on the green concrete, commonly called "the monolithic construction." (2) The laying of the brick on a superfoundation of cement-sand commonly called "the semi-monolithic construction."

Advent of a brick 3 inches in depth due to the new methods of construction and discussion of the advantages of a 3-inch brick.

Discussion of the details of construction of the monolithic type.

Discussion of the details of construction of the semi-monolithic type.

(Slides will be used showing the different steps of construction.)

The Causes of Cracks in Cement-Concrete Pavements: A. T. GOLLDBECK.

This paper gives data on the relative effect of moisture and temperature in causing cracking of concrete pavements. The results of laboratory tests on the effect of moisture on concrete are given as well as the results of field measurements on concrete roads. Likewise some results of friction tests of concrete slabs on various sub-bases are presented and applied in analyzing the effect of expansion and contraction in causing cracks. Finally, the effect of lack of uniform support by the sub-base in causing longitudinal cracks is pointed out.

A Condition Survey of Concrete Roads in the United States: A. N. JOHNSON.

The Necessity for Adequate Methods of Waterproofing in Road Construction: B. A. MEYER and C. J. MORRISON.

A wheel and a road may be considered as two elements of a machine and the ideal requisites for each determined to be:

1. Perfectly hard and perfectly round wheel.
2. Perfectly hard and level road.

The ideal road can not be maintained, but can be approached by constructing a moderately hard road which resists wear and disintegration.

In order to fulfil their requirements roads must be water-proof so as to protect them from the flowing, undermining and penetration of water. Principles of waterproofing are simple, but are neglected. Illustrated by drawings and pictures.

Roads are constructed under five general conditions:

1. On level ground.
2. On inclined ground.
3. In cuts.
4. On embankments.
5. On side of slopes.

Each condition requires a different method of waterproofing, and waterproofing is dependent upon:

1. Location of drains.
2. Construction of road.
3. Treatment of surface.

Comparative costs of construction and maintenance show that at the end of five years the total cost of a non-waterproof road and that of a semi-water-proof road are about equal, but that the former is practically useless while the latter shows little deterioration.

Similar comparisons for waterproof roads are not yet available.

Columbia River Highway: GEORGE C. WARREN.

The fourth session was held in the morning, Friday, December 29, in the engineering building, Columbia University, Vice-president, Dr. Henry M. Howe in the chair, with an attendance of about 45.

The program of the session, which was devoted to general engineering, was as follows:

Modern Methods of Precise Leveling in the Coast and Geodetic Survey: WILLIAM BOWIE.

Development of the Systematic Hydrographic Survey: N. H. HECK.

Difference in popular and scientific attitude toward the two branches of the Coast and Geodetic Survey work.

Lack of appreciation of hydrographic problems with reasons. Conservatism of sea reacts on survey methods. Instances.

Numerous sources of possible error to be eliminated. Pressure of commercial needs interferes with experimental work.

Closer attention to care in location. Elimination of errors due to currents in certain offshore areas. Startling results of a simple change. Improvements in depth measurements. Possible errors in a long-established method.

Failure of vertical method of developing all bottom contours introduced need for wire drag method. Mathematical definition. Aims and classification.

Practise in deep water work. Outline of nature of problems in close to bottom wire drag surveys. Surface observation insufficient. Analysis of action of wire in striking an obstruction with observed phenomena. Geological phase. Experiments and conclusions.

Estimate of value of method and results. Improvements in apparatus and instruments. Standardization of measurements. Definite recognition of need for experiment and research in all branches will lead to continuous improvement in results.

The Engineer and the Newspaper: Henry A. Wise Wood.

Herein Mr. Wood first recounts the origin of the practise of engineering science as a civilian occupation. He then describes the slow development in printing during the first eighteen centuries, commencing with the manufacture of paper, and relates to the improvements as they took place up to the nineteenth century, when the engineer took the art in hand, transforming it from a hand-worked to an automatic basis. Mr. Wood then dwells on the more extensive improvements made in printing during the nineteenth century, particularly in the printing press.

Having brought the press to its present state of perfection, he enumerates the other improvements in printing. In connection with the composing room he expounds the revolutionary advantages of the linotype, and in disclosing the improvements made in the stereotyping room he explains the processes which transformed it from a hand-worked into an automatically-operated department—the autoplate, introduced early in the twentieth century, being the principal factor.

Mr. Wood then passes on to the newspaper's latest achievement, the stereotyper's dry matrix, with which the history of printing ends. And he closes with a prophecy that the next step forward in printing will be taken in the printing-press department.

Independent Laboratories in the Engineering Industries: Clayton H. Sharp.

The university is the proper place for pure scientific work; that is, work done without any commercial motive. The large manufacturing organizations have recognized the importance of industrial laboratory work and many of them have organized extensive laboratories for their own purposes. The small manufacturer, being unable to establish an efficient laboratory of his own, may take his work either to a technical school or to an independent industrial laboratory. The technical school is, however, unsuited for many classes of industrial work through limitations of equipment and because, being organized for purposes of education, industrial work does not fit properly into its scope. The best solution of the laboratory problem of the small manufacturer is recourse to independent laboratories, adequately manned and equipped and supported by the work which they do. Such laboratories may offer facilities quite comparable with those of the laboratories of the great corporations and should, if adequately supported, prove an important factor in industrial progress.

A Study of the Relation between Tension and Magnetic Permeability: James T. Rood.

Magnetic curves are commonly assumed to hold irrespective of conditions under which material is to be used. Is this correct?

Does tension effect permeability of magnetic materials?

Does this change with material?

What is the magnitude of this change?

Tests on cast iron showed permeability unaffected by tension.

Tests on wrought iron showed permeability considerably affected by tension. To top of knee of B–H curve, tension below a certain amount increased permeability, greater tensions decreased permeability. Above knee, all tensions up to elastic limit decreased permeability. Higher the stress, the greater the percentage decrease; higher the degree of saturation, the less the percentage decrease.

Tests on steel showed permeability to be affected in the same manner as wrought iron.

With these materials the increase and decrease in permeability may be as high as 20 per cent.

Effect seems to increase as elasticity of material decreases, but cast iron is an exception.

The presence of carbon may be a determining factor.

Notes on the Theory of the Air Core Auto-transformer: Walter L. Upson.

The theory of the auto-transformer, especially the non-ferric type, is worked out by the method of complex quantities. It is pointed out that the resistances and leakage reactances of air-core transformers being constant and the magnetizing current being directly proportional to the impressed voltage, the characteristic performance is entirely dependent on the voltage and when known for one value of voltage may be immediately found for any other voltage.

A brief discussion of the peculiar characteristics of this apparatus is indicated by theory is

given, and an example is worked out from assumed constants.

The paper is of a preliminary character, intended to open up the general problem and suggest what may be expected by a more exhaustive study from the experimental standpoint.

Medical Engineering: P. A. MAIGNEN.

Medical engineering is defined as medicine viewed from the angle of engineering.

The author refers to the great interest manifested in our days in sanitary science (preventive medicine) and in medical subjects generally.

He defines engineering and points out the necessity for the engineer to be ingenious.

The various divisions of therapeutics—natural, applied, empirical and rational—are referred to.

Serum therapeutics is criticized.

The excessive fear of microbes is disapproved, but it must be recognized that more than half the diseases are of bacterial origin and that we must declare war against the bacteria, and carry it on with appropriate weapons on the surfaces without injuring the healthy tissues.

The author points out the procrastination of the sick, and the desirability of the state paying the physicians in civil life, as it already pays the army and navy surgeons. The education of the people in the rudiments of antiseptic therapeutics is also recommended.

The discovery of an effective, non-poisonous germicide is explained, and it is suggested that antiseptic surgery, which has been somewhat neglected of late, will return to the front.

He gives the formula of the new antiseptic, which is 3½ times stronger than carbolic acid and may be taken internally in the respiratory and alimentary tracts.

A few words about tuberculosis and cancer close the paper.

Mathematical Education for Civil Engineers: D. J. MCADAM.

The paper does not undertake to discuss the mathematical curriculum in our engineering schools as a whole, but points out some defects in the teaching of the standard subjects, algebra, the geometries, the trigonometries and calculus.

These defects are: (1) Wrong or defective statement and development of the fundamental propositions such as, for instance, in the definition and development of the trigonometric functions in trigonometry, and the proof of the rules for differentiation in calculus. (2) Insisting on secondary rules and formulæ with as much zeal as on the primary and fundamental. For instance, the multiplicity of formulæ in plane trigonometry, which should be developed from half a dozen, and in spherical trigonometry, which could be developed from less than half a dozen. (3) Burdening the student with useless details. Thus, in algebra he is required to commit the quotient having given dividend and divisor, and he is to remember four rules for solving a quadratic trinomial instead of one.

The Effect of Such Teaching.—(1) The student is made to carry in his mind—temporarily—such a mass of detail that he proceeds to forget it all, including the fundamentals.

(2) The student fails to get a mathematical education at all. He fails to grasp the true mathematical import who does not find in it a means of taking a few fundamental principles and with them working wonders.

(3) Such study of mathematics defeats the aim of even those who would have mathematics studied as a means of discipline. No study can be truly disciplinary which instead of awakening love and enthusiasm, begets discouragement and disgust.

The Remedy.—If teachers insist on following the text-book, then the remedy is in having prepared sets of books, which would present only fundamental propositions as primary, and give these secondary propositions as exercises.

In the calculus it is suggested that we have a set of small volumes, the first developing the fundamental propositions, the other volumes, each after unfolding the fundamentals, should follow this with problems wholly worked by the calculus.

Apparatus and Process for the Treatment of Western Grown Flax Straw for the Manufacture of Paper: GEORGE D. BURTON.

State Engineering Experiment Station and Government Promotion of Industrial Research: PHINEHAS V. STEPHENS.

This paper discusses a system of state industrial research in state engineering experiment stations connected with a well organized and equipped engineering school and established under federal aid and supervision. The stations to be also supported and directed by the state for the purpose of prosecuting research in pure and applied science relating to industrial development, transportation, sanitation, irrigation, the utilization of our natural resources and the general problems of public welfare. The system includes the actual cooperation of the Department of Commerce and also that of engineering and scientific societies, manufacturers, foundations and individuals interested in scientific and industrial development.

The plan provides for the training of engineers as scientists and research experts, the use of graduate students for research and the employment of research experts as lecturers and instructors part time in the regular courses of engineering and science in the schools where the stations are established. There is included a universal research library system, making easily available the important information resulting from the researches in the proposed engineering experiment stations.

The fifth session was held in the evening of Friday, December 29, in the auditorium of the United Engineering Society building at the invitation of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. Vice-president Dr. Henry M. Howe presided. The attendance was about 325.

The program of the session, which was devoted to the subject "Interrelationship of Engineering and Pure Science," was as follows:

Address by Dr. Henry M. Howe, vice-president, Section D, A. A. A. S., and past-president, American Institute of Mining Engineers.

Address by Dr. Bion J. Arnold, retiring vice-president, Section D, A. A. A. S., and past-president, American Institute of Electrical Engineers.

Address by Clemens Herschel, president, American Society of Civil Engineers.

Address by Dr. Ira N. Hollis, president, Worcester Polytechnic Institute, and president, American Society of Mechanical Engineers.

The session was followed by a reception, dance and collation tendered by the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers to the American Association for the Advancement of Science.

ARTHUR H. BLANCHARD,
Secretary

MINUTES OF THE COUNCIL

THE council met in the U. S. National Museum, Washington, D. C., on Tuesday, April 17, 1917, at 4:45 P.M., Mr. Humphreys, vice-president, in the chair. The following members were present: Messrs. Van Hise, Pickering, Nichols, Cattell, Fairchild, W. A. Noyes, Merritt, Kober, Humphreys and Howard.

The committee on policy submitted a report through its chairman, Mr. Nichols, and, on recommendation, the following actions were taken by the council:

On nomination, Mr. E. L. Thorndike, of Columbia University, was elected vice-president and chairman of Section H, in place of Mr. E. B. Titchener, declined. On nomination, Mr. E. K. Strong, of Nashville, was elected as secretary of Section H for the unexpired term of one year, vice Mr. MacCurdy, resigned.

On motion, the following societies were admitted to affiliation with the American Associón for the Advancement of Science with privilege of the waiving of the entrance fee to such of their members as may join the American Association for the Advancement of Science during the current year:

Society of College Teachers of Education,
National Society for the Study of Education.

On motion, the general secretary was instructed to inform the officers of the National Education Association that the American Association for the Advancement of Science would welcome the National Education Association as an affiliated society. It was moved to amend the original recommendation of the committee on policy to include also the American Association of University Professors in the above action.

On motion, it was resolved that the general secretary be authorized to prepare and publish, with the assistance of the permanent secretary, a membership list of the American Association for the Advancement of Science provided it could be done without expense to the association.

An informal report was made by Mr. Nichols to the effect that the proposed alterations to the constitution and the formulation of by-laws were in definite shape and would be ready for presentation at an early date. It was, on motion, resolved that, upon the completion of the committee's work, the results be published in SCIENCE with such memoranda as may be desirable, this publication to be at least one month prior to the Pittsburgh meeting. On separate motion, it was resolved that the publication carry with it an invitation for comment from members.

The permanent secretary read a tabulated list covering the accessions of new members during the past year under the Columbus resolution waiving the entrance fee to members of affiliated societies.

The permanent secretary presented his financial report for the fiscal year, November 1, 1915, to October 31, 1916, which, on motion, was accepted and ordered printed in SCIENCE.

Through its secretary, the committee on grants made an informal report covering the recommendations of the committee for the disposal of the $4,000 currently available, with the understanding that the full report will be published in an early issue of SCIENCE. Mr. Pickering, chairman of the above committee, stated that the committee favored the expenditure each year of the entire amount available.

A letter from the Pacific Division with regard to the activities of that division in connection with matters of preparedness policy on the Pacific coast, was read by the permanent secretary. On motion the permanent secretary was instructed to inform the Pacific Division of the appreciation of the council of the important work which that division is accomplishing.

At 5:20 P.M., the council adjourned.

L. O. HOWARD,
Permanent Secretary

FINANCIAL REPORT OF THE PERMANENT SECRETARY

L. O. HOWARD, PERMANENT SECRETARY, IN ACCOUNT WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FROM NOVEMBER 1, 1915, TO OCTOBER 31, 1916

Dr.

To balance from last account		$4,616.04
To receipts from members:		
Annual dues, 1916	$30,856.00	
Annual dues, 1917	170.00	
Annual dues, previous years	320.00	
Admission fees	1,255.00	
Associate membership fees	12.00	
Life membership fees	1,000.00	$33,613.00
To other receipts:		
Sale of publications	52.52	
Miscellaneous receipts, as follows:		
One (1) patron ($50 previously paid for life membership	950.00	
Treasurer's payment towards subscriptions to SCIENCE for life members, two years—1914 and 1915	793.89	
Interest on deposits, sale of programs, postage, refund from Columbus local committee.	442.47	$2,238.88
		$40,467.92

Cr.

By publications:		
Publishers SCIENCE	$21,292.05	
Preliminary announcement, circulars, forms, etc.	854.87	$22,146.92
By expenses Columbus meeting:		
To secretaries of sections, general secretary and secretary of council	666.78	
To badges, help and general expenses	272.68	939.46
By expenses of Pacific Division:		
To salary of assistant secretary	1,200.00	
To allowance for office expenses	600.00	
To allowance for extension of membership	521.55	$2,321.55
By expenses of Washington office:		
To salary of permanent secretary	1,500.00	
To salary of assistant secretary	1,500.00	
To extra help	981.07	
To postage	1,288.67	
To office supplies, stamp affixer, etc.	170.74	
To expressage, telephone and telegrams	89.96	$5,533.44
By propagandist work:		
To clerical assistance	1,265.07	
To postage	1,974.00	
To stationery and printing	1,693.05	$4,932.12
By miscellaneous disbursements:		
To treasurer, transfer of Colburn bequest	750.00	
To refund of dues	8.00	$758.00
		$36,631.49
By balance to new account		$3,836.43
		$40,467.92

The foregoing account has been examined and found correct, the expenditures being supported by proper vouchers. The balance of $3,836.43 is with the following Washington, D. C., banks:

American National Bank of Washington	$1,599.95
American Security & Trust Company	2,236.48
	$3,836.43

HERBERT A. GILL,
Auditor

WASHINGTON, D. C.,
April 16, 1917

SCIENCE

FRIDAY, MAY 4, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-On-Hudson, N. Y.

SOME OF THE SCIENTIFIC PROBLEMS AND DUTIES AT OUR DOORS[1]

WE are here at the second meeting of a new endeavor on the part of the American Association to foster an interest in scientific work and in scientific research, and it is sincerely hoped that we shall worthily do for and in this portion of our country what the parent association has done for the country at large, and what the British Association has so long been doing for Great Britain. It is for us not only to keep alive the interest in the good work of the general organization, but to widen its scope, to extend its influence and to bring it to a higher degree of usefulness.

Our national association has been a power for good in this country from its inception in 1848, for it has helped to awaken and has kept alive a widespread interest in science throughout our country, and it has brought together and kept in touch with each other persons interested in the various branches of science.

Since 1831 the British Association for the Advancement of Science has been a powerful and even a remarkable agency in the encouragement of local workers in Great Britain, and in the quickening of interest in every branch of science. But while the British Association has of late years visited Australia, Canada and South Africa, from the outset most of its activities have been confined to England, Wales, Scotland and Ireland, an area (121,112 sq. ms.) smaller than that of the state of

[1] Presidential address before the Pacific Division of the American Association for the Advancement of Science, at Stanford University, California, April 5, 1917.

California alone (158,360 sq. ms.), and having a population of forty-five millions as compared with California's one and a half millions at about the same period. But when we consider that we are expected to hatch out the eggs of science over the area extending from the Rocky Mountains to the Philippine Islands, and from the polar regions in northern Alaska to the torrid zone, we must realize that we have entered upon no trifling undertaking.

These facts are mentioned in order that we may not have false ideas of the relations of our population to the area of our operations—a factor in the problem that can not be overlooked. In a denser population where interest in any one subject has a large following it is comparatively easy to keep that interest alive and active. With our smaller population scattered over a vast area, and that population but indifferently provided with educational facilities, we must expect to meet obstacles that are inseparable from a country as new as this of ours, and to find it necessary to make extraordinary efforts if we would look forward to extraordinary results.

Many of the people about us here on the Pacific coast are quite as well prepared to do scientific work as any in the world, but we can not shut our eyes to the fact that the great bulk of our population are engaged in the work of pioneers whether they live in cities, villages, on farms, in the forests, or in the mines. Our educational institutions are manned by as able scholars as can be found anywhere, but the number of such scholars is small, while the library and laboratory equipments at their service are more or less defective. We must huddle together, as it were, to keep warm and to keep up our courage.

But even if we are still living in the pioneer days of science on this coast, we have the rewards of pioneers for whatever we may do: we live in the open, we have a certain independence that is worth much to the student of science in the way of encouragement of originality, while the fact that we are thrown on our own resources in many respects has decided advantages for young workers, and even for the older ones.

Our Duty to the Public.—We may well ask ourselves what duties devolve upon us as live and active members of this lately formed organization of scientific men with its center of activities right here about the Bay of San Francisco. My experience with the work of the American Association and with the British Association cover a period of thirty-five years, so that in making a few suggestions in regard to what seems to be the legitimate scope of our future operations, I shall not be drawing entirely upon my imagination.

The benefits to be derived from such an organization are, or should be, vastly more than what is to be expected from the simple conferring together of those who are interested in similar kinds of scientific work.

What of our relations to the public? In my opinion we have no more serious duties than to have and to cultivate a broad and intelligent interest in science as it is related to society at large. If we do not have such an interest we fail in one of our most obvious opportunities as men of science and as public-spirited citizens.

Scientific questions often arise in the discharge of the duties of our public executive officers. Our presidents, governors, judges, mayors and others in public office need the services of men of science, while legislators who have to legislate upon matters that involve scientific problems are equally in need of the advice of competent and unbiased men. It is clearly our duty to place our knowledge, our training, and our best judgment at the service of such men, and thus at the service of the public,

and to stand together in whatever is right in connection with matters relating to or involving a knowledge of science.

Legislation.—In any and every state a glance at a list of the bills introduced in the legislature can not fail to impress us with the need and the importance of a knowledge of various branches of science on the part of our legislative and executive officers. Legislative support for our scientific bureaus and for higher education must come from the backing given them either directly or indirectly by men of science. But when executive and legislative officers are chosen as ours are it would be a mere accident if they had the special knowledge necessary to legislate about matters that require such knowledge. Indeed it not infrequently happens that our public officials have their judgment biased by hearsay information and prejudices that are difficult to deal with.

Take as an example the case of legislation upon vivisection that has lately been up right here in our own state. We are impelled to ask what is to be expected from legislation on such a subject unless the men of science in the state make themselves heard and felt. Not that most of us really know anything about vivisection; we do not. But we do know what scientific methods are and where they lead, and as men of science we are bound to use our influence in support of such methods. Physiologists—not sentimentalists—are the ones to determine whether or not vivisection should or should not be allowed, and our voices should be heard in support of the physiologists and in favor of right methods in that as in anything else.

The new kelp industry of our coast already has problems in our state legislature. Surely the questions involved in this and in all similar cases should not be left to haphazard legislation dictated by selfish interests of any kind whatever, but should be settled by scientific men as scientific problems that concern the community at large.

I might well add the importance of scientific knowledge in the drafting and passing of fish and game laws, laws relating to the seal fisheries, to insect pests, to smelter fumes, to the conservation of timber, and to rational methods of mining and the conservation of our mineral resources, all of them problems closely related to our industries and to our future.

I have heard it objected that we have no call to offer our advice where it is not sought. This raises a point in ethics which puzzles some persons unnecessarily. We have also heard of a person who would not rescue a drowning man because he had not been introduced to him. We do not hesitate to cast our ballots and to lift our voices in favor of what we regard as right methods in public affairs. Nor should we hesitate to do any other act that we know to be for the public good, whether that act be formally called for or not.

I merely mention these instances in passing and as examples of some of the public duties of scientific men which we too often overlook. Such problems confront men of science everywhere, and it is to be hoped that we shall not evade them in this the newer part of our country.

SCIENTIFIC PROBLEMS

If I were asked by this association to suggest problems that the scientific world has a right to expect us to solve, or at least to attack seriously, it would bring to mind first of all the most scathing criticism I ever heard of any scientific man—a criticism made on the ground that he had spent a lifetime in a certain field where he had a unique opportunity for solving certain problems that he never solved, and that he

never made any serious effort to solve. Evidently the man had no powers of imagination, and no comprehension of the importance or bearing of the problems under his feet, and he seemed to stare and blink at them like a dazed owl. What little he did lacked purpose enough to keep him awake and at work, while ordinary professional courtesy prevented others from going into the field that accident had placed in his incompetent hands. And what has that to do with us?

One's life as a scientific man is like his life as an individual in this, that he has the hope of rounding it out satisfactorily and of leaving his work well and conscientiously done. We can not conceive, therefore, of anything more humiliating to us in our professional capacities than a failure to attack the problems that nature or opportunity has placed under our hands.

I can imagine some one objecting to local problems as not being big enough for full-grown men. It is true that the laws of science are world-wide, they are even as wide as the universe itself. None the less some of these problems have been solved right here on this humble little earth of ours, and, if we are big enough, we may yet solve more of them right here in the state of California.

Some problems are necessarily localized; and nowadays when one wants to study a thing he goes where the thing is. And that is just another way of saying that laboratory work is best done in a laboratory, while field work is best done in the field where one can see his materials in abundance.

What have we here that they have not everywhere else in the world? What local problems have we that are well worthy of our attention and of our best efforts? I can only mention two or three of them, and these must be accepted simply as examples.

Chemistry.—For the chemists we have one of the great oil, gas and asphaltum regions of the world with all of the complex problems connected with the origin of petroleum and with the vast number of products derived and derivable from it.

We have here too a great number of lakes of concentrated waters: soda lakes, borax lakes, and salt lakes, with an infinite number of interesting problems that call for solution, and offer substantial rewards for it.

The availability of a cheap and abundant supply of electricity affords unusual opportunities for studying and investigating electro-chemical subjects.

In the presence of these subjects and opportunities the chemists seem to stand on the shores of a vast and uncharted ocean that they hardly dare embark upon.

Tropical Diseases.—The territory allotted to the Pacific Division of the American Association includes large areas in the tropics—Mexico and the Sandwich Islands, and the Philippine Islands. These facts, and the opening of the Panama Canal and the growth of trade, and the development of commercial intercourse between our western ports and tropical countries, and especially between us and Asiatic countries, ought to impress us with the importance of our study of tropical diseases. Soon or late we shall have to deal with such diseases, and unless we undertake the work promptly and with thoroughness we shall pay dearly for it later on. If we are not willing to do this from our interest in science, we shall have to do it as a matter of self-protection. The port of San Francisco is close to every town on this coast, and it is at San Francisco that tropical diseases are most likely to land.

Geology.—As I have said, these cases are cited merely as examples, for I find that there is hardly a branch of science that has not here, within our province, an em-

barrassment of riches well worthy of the best efforts of our best men. I therefore pass over most of these subjects and come to geology, with the problems of which I am more familiar. And if I speak of them more at length, it is because of that familiarity, and not because I regard them as of more importance than those of other branches of science. But even in speaking of geology, whose local problems are remarkably numerous and important, I am obliged to confine myself to a single topic.

We have in geology an excellent illustration of the importance and of the splendid results to be expected in attacking some of the problems under our hands. The fossil vertebrates found in the asphaltum deposits near Los Angeles have been promptly and thoroughly looked after by our colleague Dr. Merriam, of the University of California, with results that have not been surpassed by any work of the kind done in any other quarter of the globe. How fortunate for us and for science that Dr. J. C. Merriam did not think a local problem unworthy of his attention.

Earthquakes.—But I regret to say that we also have here a geological problem of another kind. I hesitate even to mention it, perhaps because an old Spanish proverb says that "in the house of a hangman one should never mention rope." And in California one has to take his courage in both hands when he says "earthquake."

Here is a problem, or rather a great group of problems, that nature has left on our very doorsteps. What are we doing with it, and what do we propose to do?

The earthquake of 1906 jolted us into a state of temporary wakefulness, but we seem calmly to have gone asleep again. The only thing to our credit in connection with it is the excellent report of Dr. A. C. Lawson, which stands out, and stands alone, as a contribution to seismology in this country. Very largely through the impetus given to the study of seismology by the earthquake of 1906, the Seismological Society of America was formed here in California in the hope that we might get the cordial support of scientific men and of public-spirited people generally in the study of earthquakes.

Through the patient exertions and personal sacrifices of a handful of men and through the generous contribution of our colleague Mr. Robert W. Sayles, of Harvard University, we have been able to publish six volumes of the society's quarterly bulletin and to get started on a road that seems to lead somewhere.

I am merely stating a fact in connection with this subject when I say that instead of taking hold of the problems of the earthquakes, most of us seem disposed to run from them; or what is still worse, we deny their very existence, while the cooperation and help we hoped to receive from the public has not been forthcoming. Certain branches of business are especially liable to damage from earthquakes, and it seems quite reasonable that such industries should cooperate with us by gathering and sending in data regarding earthquakes as they occur. Our railway lines, with their many bridges, cuts and fills, are liable to be seriously damaged and their service interrupted, to say nothing of the possible danger to human life through trains running into dislocations; our telegraph and telephone lines are liable to be broken and their service interrupted; our electric power companies are liable to have their dams injured, their pipe lines and wires broken, and their service seriously interfered with; our water companies are liable to have their dams injured or destroyed, their water mains broken and their service impaired; while our insurance companies are perplexed by rate problems in a region

where, in order to protect themselves, they are compelled to make their customers pay for risks about which we are all equally ignorant. As a matter of fact not a single railway or tramway company, not a single telegraph or telephone company, not a single insurance company, not a single electric power company, and only one water company—the Spring Valley Water Company of San Francisco—has ever manifested the slightest interest in our work or lifted a finger to help us gather the data necessary for a rational study of the earthquake problems of this coast. What could we not do if we had the cordial cooperation of all such organizations on this coast? It seems almost incredible that the business interests of this state and of this coast should willingly and weakly, year after year, allow a permanent threat to hang over their industries, their transportation lines, their public utilities, and their very existence, without making an intelligent effort to study the subject or to help those who are willing and anxious to study it, and to find means of meeting it. Yet such are the sad facts.

What is the explanation of this remarkable state of affairs? So far as I am able to judge, it comes from the false attitude into which the people of this coast have unwittingly drifted. At the time of the earliest settlement of the Pacific coast by whites, pious people grouped the earthquakes along with a choice lot of other disasters and calamities commonly known as "acts of God." And naturally enough pious people regarded the acts of God as things to which we should take off our hats, but which should not be questioned or irreverently pried into.

In time they came to be simply accepted as drawbacks to the general attractiveness of California, and as such it seemed best to regard them as evils to be endured but not to be talked about. Here was a great and beautiful land that lacked capital, a good class of immigrants, and the development of its natural resources; and nothing must be said or done to frighten away either the capital or the immigrants. If the news of an earthquake occasionally made its way out of the state it was immediately given a back seat by being confronted with the enormous damage done by destructive tornadoes and annual floods in the Mississippi Valley. Our real-estate agents rarely or never heard of earthquakes; it seemed better that they should not; such things interfered with business. About the same time the newspapers fell into the habit of forgetting to mention them, and there seemed to grow up spontaneously a sort of conspiracy of silence in regard to the subject. And so it came about that when the earthquake of 1906 broke the water mains of the Spring Valley Water Company and at the same moment set fire to the city of San Francisco, we were entangled in the snares of our own weaving. And now see how we tried to hide our heads in the sand. The geologists hereabout were very anxious to gather the data made available by that particular earthquake, but as the necessary field work required considerable funds efforts were made to interest some of our business men in the subject. But our business men rose up almost to a man and assured us in the most emphatic language that there had been no earthquake, and we were told to "forget it"; to "cut it out," and above all, to publish no report on it.

It is not necessary to tell this audience that such an attitude is false and absolutely untenable. The battles of science can not be successfully fought with the weapons of ignorance and bigotry.

I am confident that this state of affairs can not long endure. Very likely indeed we have not done our own duty in pointing

out what seems to be a rational method in handling the whole matter. But a rational method demands first of all that we face about and get on the right road.

Science knows but one way to deal with its problems, and that is to face them in the open; that is the doctrine to be preached, and to be practised; and it is the only one.

The more I study earthquakes the more I am convinced that their dangers have been greatly exaggerated by our ignorance and through our efforts to cover them up; and the more am I convinced that a systematic study of the subject on this coast will yet enable us to outline with reasonable precision the areas in which they are liable to be severe, and in this way we may yet do away with their greatest dangers. Such work should eventually enable us to locate dams, bridges and buildings with reference to earthquake risks, and it should enable the insurance companies to deal justly with their customers, and, at the same time, to protect their own legitimate interests.

But such work can not be done in a month or a year, nor yet in ten years. Neither can we depend on the stimulation of violent earthquakes to keep people alive to its importance. Indeed, very little is to be expected of people who require violent stimulants to keep them going. Machinery of that kind generally stops when the stimulants give out. Those who enter this field should be people of some steadfastness of purpose, and who have little or no ambition to pose or dance in the limelights.

It will require years of careful collaboration, of patient gathering of data, of careful study, the mapping of the areas in which the shocks are felt, and the study of the geology in order to know just what is going on, and what is likely to happen.

To those who may think favorably of helping us in our efforts to study earthquakes I should speak this word of warning: Don't expect too much of us, and don't expect it too soon. Science must go its own gait, in its own way, and it often finds itself in a blind alley. It is trying; we wish it were otherwise; but it can not be helped. We can not trust the methods, dogmas or conclusions of authority in science.

Science bows down to truth and to truth alone; we have no apologies to make for its methods, its processes or its conclusions. The more we know about the complications and apparent contradictions of absolute truth, the more we distrust the cocksure and the authoritative settlement of scientific problems. To many minds authority points out the only satisfactory way and not only insists upon it, but cites volume, chapter and page to prove it, while science hesitates, vacillates, theorizes, and, brazenly or weakly, confesses its ignorance. There is no doubt about which one of those guides the crowd will follow, but neither is there any doubt about where a crowd, so led, must finally come out. Eça de Queroz quotes a learned writer as stating that "Adam, the father of men, was created October 28th at two o'clock in the afternoon." Here speaks authority, and we must confess that it offers us a clean-cut starting point for the human race that does away at a single stroke with the doubts and hesitations of modern science.

Compare this with the confession of a modern, conscientious physician who is called to attend a sick child. He asks a great many questions, he takes temperatures, and he does everything he can to discover the nature of the illness, and finally when asked point blank what ails the child, he replies: "Mrs. Blank, I'll be doggoned if I know what the matter is with the baby."

People who depend on hocus-pocus, and are on the lookout for the psychology of the

case would probably say that such an admission is a psychological error, but I am sure that it warms the heart of every scientific man to find a man who has the courage to tell the unvarnished truth, however much he may regret the necessity of it. And we shall have to follow this course and no other in dealing with earthquakes. In this spirit we need the cooperation and support of all men of science, and we feel that we are justly entitled to such support. We also need the support of business men, and we feel that we are equally entitled to it.

Very likely some of you may feel that you do not like to have this or any of these local problems flung at your heads in this brusque fashion. But, my friends, nature has already flung these problems, not only at our heads, but in our very faces. Is it not for us to wake up and be equal to our opportunities? Unless we take hold of the problems of seismology that are so conspicuously our problems here on this coast we shall stand justly discredited in the minds of our colleagues in other parts of the world. The Portuguese have a proverb about people who "fetch water after the house is burned up." Let us see if we can't fetch the water in season.

And while I am using plain language about disagreeable things, I may as well refer to one more unpleasant subject, and have done with it, and that is the necessity of financial backing. Men of science can do the work of science, but they can not foot the bills. For that part of this undertaking we must look to business men. And we look to them with confidence that they will cheerfully do their part. And if we will all pull together and keep up our courage, I feel confident that the day will come when earthquakes will have lost most of their terrors, not only for us on this coast, but for the human race.

Let me end with the words of a California author (Edward Rowland Sill) on opportunity:

OPPORTUNITY

This I beheld, or dreamed it in a dream:
There spread a cloud of dust along a plain;
And underneath the cloud, or in it, raged
A furious battle, and men yelled, and swords
Shocked upon swords and shields. A prince's banner
Wavered, then staggered backward, hemmed by foes.
A craven hung along the battle's edge,
And thought, "Had I a sword of keener steel—
That blue blade that the king's son bears,—but this
Blunt thing—!" he snapt and flung it from his hand,
And lowering crept away and left the field.
Then came the king's son, wounded, sore bestead,
And weaponless, and saw the broken sword,
Hilt-buried in the dry and trodden sand,
And ran and snatched it, and with battle-shout
Lifted afresh he hewed his enemy down,
And saved a great cause that heroic day.

JOHN CASPER BRANNER
STANFORD UNIVERSITY

SCIENTIFIC EVENTS

THE USE OF PRIMITIVE ART IN TEXTILES

IN answer to the demand of the American textile industry for designs inspired by the primitive art of this continent, the American Museum of Natural History of New York City on April 16 sent Dr. Herbert J. Spinden, of its department of anthropology, to make special researches in Central American countries. His mission is a development of the policy of the institution to exert a formative influence on modern industry. The European War placed manufacturers of textiles largely on their own resources, as far as designs were concerned. Previously they had been guided largely by the traditions and example of Paris. The museum, recognizing this condition, placed all of its resources and research material at the command of the American looms, and its collections were studied by designers from all parts of the United States. The recent exhibition of figured textiles in the museum conveys an idea of the success which has attended the intro-

duction of the primitive art motif into modern designing.

Dr. Spinden will begin forwarding specimens to New York as soon after his arrival in the field as possible. He will start in Guatemala and extend his investigations to western Honduras, Salvador and Nicaragua. In these localities are small groups of Indians most interesting for their civilization and culture, although comparatively little known. Dr. Spinden will not only obtain examples of designs but will also learn the details of the art of weaving and study the dyestuffs used by the native artisans. The costumes worn by the Indians of Central American countries are not only picturesque, but have many details of construction which might be successfully adapted. The fundamental ideas on which these garments are based are said to be unique.

Dr. Spinden will also get all possible information concerning the native food products with a view to calling attention to their economic value, which is often very great. Specimens of these alimentary substances will be collected for display in the Preparedness Exhibit which the American Museum now has under way. Dr. Spinden will be accompanied by S. G. Morley, of the Carnegie Institution of Washington, who is likewise interested in the archeological features of the expedition. The work is undertaken with the official sanction of all the Central American governments. Most of the traveling will be on mule back through mountainous and sparsely settled regions and over native trails. Dr. Spinden left New York on April 16 and expects to return in about three months.

RESEARCH WORK OF THE LEANDER McCORMICK OBSERVATORY

The visiting committee of the Leander McCormick Observatory of the University of Virginia met in Washington on April 17. The director reported that the scientific work accomplished during the year was as follows:

1. The determination of the parallax of fifty stars, results thus having been obtained on one hundred and twenty-five stars since the parallax work was started two and a half years ago. A preliminary value of the parallax of Barnard's star of large proper motion was found to be 0″.47.

2. More than 10,000 observations of meteors were made by amateurs during the year 1916, and were sent in to the McCormick Observatory for discussion and publication. This probably makes the largest number of meteor observations ever collected in any one year, except perhaps during the years of a meteor shower.

3. A plan of cooperation has been entered into with Harvard College Observatory whereby the 26-inch refractor is to be used for the visual observation of variable stars while they are at minima. More than one hundred and fifty stars are on the program, these stars being mainly long period variables.

4. Photographs have been made with an objective grating and with yellow light in order to find the photovisual magnitudes of the Harvard Standard regions.

5. Micrometric measures by C. P. Olivier of two hundred double stars have been published in the *Astronomical Journal.*

Grateful acknowledgment was expressed for financial assistance from the Leander McCormick estate, from the special Adams fellowship from Columbia University for parallax work, from the J. Lawrence Smith fund of the National Academy of Sciences for research on meteors, and for the gift of a wireless apparatus and a computing machine from Mr. John Neilson, of New York.

THE ENGINEERING COMMITTEE OF THE NATIONAL RESEARCH COUNCIL

The following engineering committee has been appointed: George F. Swain and Edgar C. Marburg (representing American Society of Civil Engineers), Pope Yeatman and Albert Sauveur (representing American Institute of Mining Engineers), C. D. Young and William F. Durand (representing American Society of Mechanical Engineers), Frank B. Jewett and Clayton H. Sharp (representing American Institute of Electrical Engineers), Lewis B. Stillwell (representing American Institute of Consulting Engineers), John A. Brashear, George K. Burgess, J. J. Carty, Howard E. Coffin, John R. Freeman, Hollis Godfrey,

W. F. M. Goss, Clemens Hershel, M. I. Pupin, Charles F. Rand, C. E. Skinner, S. W. Stratton, Ambrose Swasey, Elihu Thomson.

Previous to the appointment of this committee the following letter, dated April 18, 1917, was addressed to the presidents of the American Societies of Civil, Electrical, Mechanical and Mining Engineers:

The National Research Council desires to increase its means of serving the government in support of National Defense by enlisting through an engineering committee the services of a group of distinguished engineers drawn from the field of engineering research in each of the four main divisions of civil, mining, mechanical and electrical engineering.

The members of this committee would deal directly with engineering research problems falling within the spheres of their experience, and would serve as representatives of their respective national engineering societies for the calling upon other members of those societies for the services which the societies have offered to the government in connection with problems of defense and other problems that have been referred to the National Research Council.

The National Research Council operates through a number of central committees covering the physical sciences, medicine, hygiene, agriculture and other subjects as described in the pamphlet, enclosed herewith, which gives the scheme of organization of the council as developed up to January 15, 1917.

The engineering committee is a central committee coordinate with the other central committees therein listed.

In addition to services in the field of engineering research the council has need of some general engineering services auxiliary to problems of research, and desires to be in a position to enlist such services in support of the general objects of the council.

These objects are, to bring into cooperation existing governmental, educational, industrial and other research organizations with the purpose of encouraging the investigation of natural phenomena, the increased use of scientific research in the development of American industries, the employment of scientific methods in strengthening the national defense, and such other applications of science as will promote the national security and welfare.

The relation of the National Research Council to The Engineering Foundation is described in enclosed report by the secretary of The Engineering Foundation.

The relation of the National Research Council to the Council of National Defense is indicated by the following resolution, passed on the 21st of February, by the Council of National Defense:

Resolved, that the Council of National Defense, recognizing that the National Research Council, at the request of the President of the United States has organized the scientific forces of the country in the interest of National Defense and National welfare, requests that the National Research Council cooperate with it in matters pertaining to scientific research for National Defense and to this end the Council of National Defense suggests that the National Research Council appoint a committee of not more than three, at least one of whom shall be located in Washington, for the purpose of maintaining active relations with the director of the Council of National Defense.

The executive committee of the National Research Council would appreciate it if on behalf of the American Institute of Electrical Engineers you would designate two engineers skilled in engineering research, whom the committee may appoint members of the engineering committee of the National Research Council, to render the services outlined in this communication and to serve as a means of calling upon other members of the American Institute of Electrical Engineers for services that the National Research Council may need in support of the national objects herein referred to.

George E. Hale,
Chairman, National Research Council,
John J. Carty,
Chairman, Executive Committee,
Gano Dunn,
Chairman, Engineering Committee

MEDICAL STUDENTS AND THE WAR

The Medical School Committee of the Medical Board of the Council of National Defense has made the following report:

In your effort to solve the urgent problem before this board and assist the surgeon general in supplying an adequate number of medical officers for the Army and Navy, it is important that this country should not repeat England's blunder at the outbreak of the war in permitting the disorganization of the medical schools either by calling the faculties into active service or sanctioning the enlistment of medical students into any of the line organizations. Ordinary foresight demands that we face the possibility that the war upon which we

have entered may last for years. Medical schools to supply trained men for the future as well as the present emergency must be kept in active operation under any circumstances. While aiding to the uttermost in overcoming the present shortage of men, the necessity of keeping the source of supply open emphasizes the importance of conserving our raw material. Therefore, men now in college looking forward to medicine as a career should be made to understand that it is their patriotic duty to the nation at this time to continue their studies and enroll in the medical school of their choice. Furthermore, no medical student who has not completed three years of medical work should be permitted to give up his course, as the country needs his trained and not his untrained service.

There are, however, ways in which the medical schools can help the present situation. The following suggestions are made for your consideration and action:

1. Medical schools should be prepared to graduate senior medical students promptly in case of need. The faculties should urge all graduates who can be relieved of their obligations as internes in civil hospitals to enroll in the medical corps of the Army and Navy.

2. Medical schools should be encouraged to consider as a form of service, the Italian plan by which base hospital units can be organized through the Red Cross. These military hospitals carry with them the clinical faculty and students as medical personnel. This type of organization meets two ends—practical help can be rendered to the Army or the Navy in time of war and instruction may be continued at the base. This permits the graduation of men directly into the junior grades of the Army after the most practical form of military instruction.

3. Fourth-year students may be allowed to substitute, in special cases, service in a base hospital for the fourth year in the hospital at home when opportunities are offered for instruction in such military institutions.

4. Medical schools that do not adopt the Italian plan should be prepared to reduce the faculties to the minimum required for routine work and enroll all men so liberated in the Medical Officers Reserve Corps.

To put these recommendations into immediate effect, the committee suggested that the Council of National Defense send a telegram to the deans of all medical schools, urging that all medical students until the fourth year is reached should be discouraged from enlisting at present in any line or sanitary organization; and another telegram to the presidents of all colleges and universities saying that national safety demands that all undergraduates planning to study medicine should enroll in the medical school of their choice at the earliest possible moment.

SCIENTIFIC NOTES AND NEWS

THE following have been elected to membership in the American Philosophical Society: *Residents of the United States:* William Frederick Durand, Ph.D., Stanford University, Calif.; Pierre Samuel duPont, Mendenhall, Pa.; Carl H. Eigenmann, Ph.D., Bloomington, Ind.; Charles Holmes Herty, Ph.D., New York; Herbert E. Ives, Ph.D., Philadelphia; Waldemar Lindgren, Ph.D., Sc.D., Cambridge, Mass.; Walton Brooks McDaniel, Ph.D., Philadelphia; Winthrop J. V. Osterhout, Ph.D., Cambridge, Mass.; Harold Pender, Ph.D., Philadelphia; Frederick Hanley Seares, B.S., Pasadena, Calif.; George Owen Squier, Ph.D., Washington, D. C.; Charles P. Steinmetz, Ph.D., Schenectady, N. Y.; Oscar S. Straus, LL.D., New York City; Alonzo Englebert Taylor, M.D., Philadelphia; Edwin Bidwell Wilson, Ph.D., Cambridge, Mass. *Foreign Residents:* Archibald Byron Macallum, F.R.S., Toronto; Sir David Prain, F.R.S., Kew.

SIR ERNEST SHACKLETON has been elected to the honorary fellowship of the American Museum of Natural History, the highest scientific honor which the institution has to bestow. This is in recognition of his Antarctic explorations and his heroic efforts in rescuing the members of his party. Sir Ernest becomes the ninth honorary fellow of the American Museum, the others being: Roald Amundsen, Dr. Bashford Dean, Lieutenant George T. Emmons, U. S. N., Geo. Bird Grinnell, Baron Ludovic Moncheur, Rear Admiral Robert E. Peary, U. S. N., Dr. Leonard C. Sanford and Vilhjamur Stefansson.

THE faculty of Wellesley College has awarded the Alice Freeman Palmer Fellowship for the year 1917–18 to Miss Hilda Hempl, A.B. (Stanford, '14), M.S. (Michigan, '15). Miss Hempl has been studying at the Serum

Institute in Copenhagen, the Lister Institute for Preventive Medicine in London, the Pasteur Institute in Paris, and is now at the Pasteur Institute in Algiers. Under appointment as Alice Freeman Palmer Fellow she will continue work in connection with the study of anaërobic wound infection and tropic diseases.

THE board of trustees of the University of Maine has established the following committees at the suggestion of the National Research Council: *From the Faculty:* J. S. Stevens, Raymond Pearl, C. D. Woods, M. A. Chrysler and C. B. Brown. *Representing the Alumni:* W. H. Jordan, G. P. Merrill, Allen Rogers, L. R. Cary and H. W. Bearce. *Representing the Trustees:* S. W. Gould, W. H. Looney and F. H. Strickland.

THE following resignations from the medical faculty and the instructing staff of the college of physicians and surgeons have been accepted by the trustees of Columbia University: Dr. George E. Brewer, as professor of surgery; Dr. Virgil P. Gibney, as professor of orthopedic surgery; Dr. Herman Von W. Schulte, as associate professor of anatomy, and Dr. Homer Fordyce Swift, as associate professor of medicine.

DR. EDWARD CAMERON KIRK, dean of the dental school of the University of Pennsylvania, and Drs. Matthew H. Cryer and Edwin T. Darby, of the faculty, have retired under the university age limit rule of 65 years.

WE learn from the *Journal* of the American Medical Association that with the close of this term Italy loses from her teaching force, on account of the age limit, three well-known professors, C. Golgi, professor of general pathology and histology at the University of Pavia, who has contributed so much to our knowledge of the nerve cell; G. F. Novara, professor of clinical surgery at the University of Genoa, and G. Roster, professor of hygiene at the University of Florence.

DR. CHARLES W. PILGRIM, president of the New York State Commission in lunacy, has been appointed superintendent and medical director of the Manhattan state hospital for the insane, to succeed the late Dr. Mabon, and Dr. Walter G. Ryan, medical inspector of the State Hospital Commission, has been appointed superintendent and medical director of the Hudson River State Hospital at Poughkeepsie.

THE Canadian government has recently appointed Dr. C. Gordon Hewitt, F.R.S.C., to be consulting zoologist, in addition to his duties as Dominion entomologist and chief of the entomological branch of the Department of Agriculture. The duties of the office will be to advise in matters relating to the protection of birds and mammals and the treatment of noxious species.

D. W. BLAKESLEE, formerly assistant professor of electrical engineering at the University of Arkansas, and now engaged in industrial work, has received his commission as first lieutenant in the Engineer Section, Officers' Reserve Corps of the army.

DR. ISAAC F. HARRIS, formerly director of the Lederle Antitoxin Laboratories of New York and later director of the Arlington Research Laboratories of Yonkers, New York, has moved from Bronxville, N. Y., to New Brunswick, N. J., where he is head of the department of biochemistry in the research and biological laboratories of E. R. Squibb & Sons.

PROFESSOR EDWIN OAKES JORDAN, chairman of the department of hygiene and bacteriology at the University of Chicago, is at present engaged in investigations in Argentina.

ASSISTANT SURGEON GENERAL HENRY R. CARTER, U. S. Public Health Service; Mr. Frederick L. Hoffman, statistician of the Prudential Life Insurance Company; Dr. Oscar Dowling, Shreveport, president of the state board of health, and Dr. William H. Seemann, New Orleans, state bacteriologist, began a tour of Louisiana on April 9, to make a survey of the malaria conditions. The survey will include thirty-five towns and cities and will be ended April 19.

THEODOOR DE BOOY, of the Museum of the American Indian, Heye Foundation, has returned to New York after a six months' archeological survey of the Danish West Indies, now the American Virgin Islands. A large num-

ber of pre-Columbian specimens were excavated in aboriginal village sites and the results of these investigations showed that the Indian inhabitants of the Virgin Island group did not belong to the same race as the inhabitants of Porto Rico, as has always been thought. Skeletal remains of contemporary animals were found in the kitchen-middens and were of the greatest zoological interest, among the finds being the remains of a flightless bird hitherto unknown from this region.

AFTER spending a considerable time in Alaska as head of the John Wanamaker expedition of the University of Pennsylvania Museum, Louis Shortridge has sent a report of his acquisitions to the museum. Mr. Shortridge was formerly a chief of the Chilkat tribe of Indians of Alaska, and is familiar with their language and mode of life. He reports having acquired three sacred war helmets, said to be the last in Alaska, a large collection of dishes, baskets, tools, boxes and sacred bundles, used by the medicine men. All these will be on display at the museum.

DR. FREDERICK H. GETMAN lectured before the chemical department of the Johns Hopkins University on April 17 and 18, on "Allotrophy and the Metastability of the Metals."

PROFESSOR R. G. AITKEN, of the Lick Observatory, gave a lecture before the department of astronomy at Smith College on April 31, entitled "Unity of the Universe."

AT the bimonthly meeting of the Society of Sigma Xi, Duluth, held on April 17, Dr. E. L. Tuoby addressed the members on the subject "Why People Die." The usual dinner preceded the address.

PROFESSOR MADISON BENTLEY, of the University of Illinois, lectured before Wilson College, Chambersburg, on April 14. His subject was "Orientation in Man and Animals."

PROFESSOR ARTHUR GORDON WEBSTER, of Clark University, gave a lecture at Wellesley College last week on "Physics and War."

THE services of the late Dr. S. Weir Mitchell, for many years a member of the board of trustees of the University of Pennsylvania, distinguished as a man of science, a man of letters and physician, are to be commemorated by the placing of a memorial tablet in the reading room of the university library.

A SPECIAL memorial service in memory of the late Professor H. W. Conn was held at Wesleyan University on April 29. Dr. Shanklin presided and addresses were made by Professor C. E.-A. Winslow, of the Public Health Department of the Yale Medical School, who spoke on the work of Professor Conn for the welfare of the public and Professor W. N. Rice, who spoke of Professor Conn's thirty-three years' service to Wesleyan.

DR. EPHRAIM CUTTER, the microscopist and food expert, died on April 25, at West Falmouth, aged eighty-five years.

THE *Journal* of the American Medical Association announces the death of D. Vitali, formerly professor of pharmaceutic chemistry at the University of Bologna, aged eighty-five years; of L. Penix, professor of pharmaceutic chemistry and toxicology at the University of Bologna, aged fifty-five years, and of A. Corona, professor of experimental physiology at the University of Parma, aged sixty-five years.

WE learn from *Nature* that Dr. J. O. Hesse, director of the Associated Quinine Factories of Zimmer and Co., for many years the leading authority on the chemistry of quinine and other cinchona alkaloids, died at Feuerbach, near Stuttgart, on February 10, in his eighty-second year.

THE permanent secretary of the American Association for the Advancement of Science has sent us the following statement of the registration at the New York meeting: The actual registration was 2,136, including 103 members of the affiliated societies, according to the following geographical distribution: Alabama, 3; Arizona, 2; Arkansas, 2; California, 16; Colorado, 3; Connecticut, 73; Delaware, 6; District of Columbia, 156; Florida, 3; Georgia, 16; Idaho, 0; Illinois, 54; Indiana, 24; Iowa, 18; Kansas, 16; Kentucky, 3; Louisiana, 5; Maine, 17; Maryland, 77; Massachusetts, 240; Michigan, 36; Minne-

sota, 20; Mississippi, 2; Missouri, 21; Montana, 3; Nebraska, 3; Nevada, 1; New Hampshire, 16; New Jersey, 133; New Mexico, 0; New York (including 450 from New York City), 703; North Carolina, 19; North Dakota, 4; Ohio, 96; Oklahoma, 0; Oregon, 2; Pennsylvania, 170; Rhode Island, 15; South Carolina, 8; South Dakota, 2; Tennessee, 12; Texas, 15; Utah, 1; Vermont, 6; Virginia, 27; Washington, 1; West Virginia, 10; Wisconsin, 23; Wyoming, 5; Germany, 1; England, 1; France, 1; Canada, 35; Argentina, 2; Brazil, 1; Japan, 2; Switzerland, 2; Hawaii, 1.

The Earl of Derby, British secretary of state for war, in moving recently in the House of Lords the second reading of the bill to review military exemptions, stated that in the battle of the Somme alone over 400 doctors had been either killed or wounded, and that at the present time the army was, if not critically, at least lamentably, short of medical men.

According to the *Journal* of the American Medical Association the quota necessary to fill the present vacancies and requirements of the Army Medical Corps will be drawn from among those who graduated in 1912 to 1916. The total number that would be included in such a list would be approximately 19,000. The list of graduates in the five years mentioned, and also for 1917, is as follows:

MEDICAL COLLEGE GRADUATES

	From Colleges in Class A	B	C	Totals
1912	2,790	1,063	629	4,482
1913	2,539	1,050	392	3,981
1914	2,626	686	282	3,594
1915	2,629	688	219	3,536
1916	2,630	695	193	3,518
1917[1]	2,641	625	101	3,367
Totals	15,855	4,807	1,816	22,478

As has been noted, there is an immediate need of additional physicians for the medical corps of the army, and for the medical corps of the navy. For these positions preference will be given to young physicians. The Army Medical Corps insists on a year's internship in a hospital after graduation; the Navy, however, is not now insisting on this, but is recognizing 1917 graduates.

[1] Seniors.

Research work in physics during the summer has of recent years grown to such proportions at Cornell that the physical laboratory is a busier place in June, July and August than during the term. To assist and encourage these workers, not by the offering of courses of instruction, but rather by occasional advice and council, arrangements have been made to have a member of the staff regularly in residence during this period who shall have no other duties. This work is entirely independent of the summer session. The arrangement is especially intended for former graduates who desire to return for a summer of investigation and for other working physicists. The member of staff in residence this summer will be Professor E. L. Nichols.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late John G. Johnson, one of the most noted lawyers in America, the University of Pennsylvania will ultimately receive a very large bequest; the exact amount can not now be stated, but it is estimated at from five to ten million dollars.

The Minnesota legislature which adjourned on April 19, appropriated for the University of Minnesota for the biennum 1917–19, a total of $3,735,500. This is an increase of $435,550 over the current appropriations. The sum made available for buildings and equipment is less than for 1915–17, but the maintenance funds have been increased by $225,000 per annum, or $450,000 for the biennum.

The University of Washington will have from the legislature and from other sources about eight hundred thousand dollars a year during the next two years.

Dr. Frederick C. Ferry, dean of Williams College, has been elected president of Hamilton College.

Dr. Alexander Petrunkevitch, assistant professor of zoology at Yale University, has

been elected full professor of zoology in the Scientific School.

THE following promotions have been made in the department of zoology at the University of California: Associate Professor S. J. Holmes to a professorship; Assistant Professors J. F. Daniel and Joseph Grinnell to associate professorships.

DR. GEORGE R. WELLS, associate professor of psychology in Oberlin College, has been appointed to a new professorship in psychology in the Ohio Wesleyan University, and will assume his duties in September. A psychological laboratory, housed in a separate building, has been provided and is being equipped at the latter institution.

M. P. MARIE, professor of pathologic anatomy at the University of Paris, has been appointed to the chair of diseases of the nervous system, to succeed the late Professor Dejerine. M. Letulle, hitherto professor of the history of medicine, has been given the chair of pathologic anatomy.

DISCUSSION AND CORRESPONDENCE

WANT OF ADAPTATION TO THE TIME OF THE PRINTING PRESS

IF the printing press is recognized as the most important instrument for the diffusion of knowledge, the advancement of science requires that it should be used with a precision like that shown in the use of the microscope or in the application of statistical methods.

It seems that this want of adaptation is shown in lack of adequate provision for, and in the common method of, the publication of scientific literature. Gifts to local establishments, in spite of their great value, seem silly compared with a proper endowment for the publication and distribution of scientific separates.

All scientific articles should be printed and sold separately, so that a student could subscribe for the literature of a certain subject. This would not prevent any one from binding together any papers he wished. Scientific publication is in a bad way, if it must be provided for by requiring one to pay for matter one does not need, and which, as far as one is concerned, is not worth shelf room. I am interested in literature relating to certain bees, but that does not incline me to pay for descriptions of Sarcophagidæ which take up eight pages for one species. In the library of the Missouri Botanical Garden I could not find papers by one author because the transactions in which they were printed did not contain enough botanical literature to justify purchase by that institution.

A magazine publishing transient articles is good enough, but one publishing important contributions to science in a various mixture is more or less of a burial place for such literature, whether one considers the persons the authors are trying to reach or those desiring to see the articles. That his writings should reach every one who is interested in them, or would profit by them, is as important for an author as it is for the student to see the writings in which he is interested—and the interests of both are in line with the advancement of science.

That the publishing of heterogeneous articles in journals is objectionable is shown by the practise of printing author's separates. But these are usually unsatisfactorily distributed and soon exhausted. The printing of separates operates against the interests of the journal when a writer avoids subscribing for it on the expectation of receiving the separates from their authors. For the sake of students a discriminative author may be inclined to publish all of his papers on a given subject in the same journal, but the journal may prefer a variety of papers in order to increase its subscription list. So, also, a paper which has some body to it is broken into monthly parts to make room for articles on different subjects. It is a question whether the magazines do not encourage fragmentary and desultory methods of investigation and publication.

On account of objection to too many, or too long, papers on the same subject, or simply inadequate provisions for publication, descriptions of American insects are often published in foreign journals—a practise clearly opposed to the interests of science. However, some au-

thors seem to have a mania for scattering literary fragments and may cultivate foreign journals merely for the sake of personal advertising.

Entomological News, 28: 141, after mentioning four journals which lasted an average of five years each, says:

> In general it seems that the number of specialists in any one or two orders of insects is not sufficient to support a special journal, and we know of none such provided with an endowment fund guaranteeing its permanency. In this matter we must still be entomologists, apparently, and yet the record of general entomological journals contains many a short-lived periodical.

The significant point here is that, while we are specialists as regards the literature we desire, we are general entomologists as regards the literature we have to pay for.

As educational institutions the university is local, while the printing press is cosmopolitan, the only cosmopolitan university. The publication of scientific literature should not be supported by requiring specialists to pay for literature they do not need, any more than the university should depend for its entire support upon the tuition of its students.

CHARLES ROBERTSON

CARLINVILLE, ILLINOIS

FUNDAMENTAL CONCEPTIONS OF MODERN MATHEMATICS

To the Editor of Science: In your issue of August 4, there appeared a review of the first part of our "Fundamental Conceptions of Modern Mathematics," from the pen of Professor G. A. Miller. Against a hostile criticism, giving a portrayal of at least some of the main theses of our book and attempting to controvert them, we would have no inclination to protest. But all the important issues raised by our treatise are ignored by Professor Miller, who dwells upon features having no bearing upon any of the arguments of our work, or upon any of the doctrines which it is the purpose of the arguments to uphold.

Surely a reviewer can be justly expected to take up at least one or two of the principal doctrines of a treatise of which he disapproves, and show that these doctrines are erroneous. Our book contains an account of quantities and their classification; an investigation into what the symbols used by mathematicians really stand for. We set forth the classification of quantities into what we call sorts, kinds and varieties, and show the importance of this classification in the subdivision (originally conceived by De Morgan) of algebraic science into single algebra, double algebra, etc. A precise statement is given of what we apprehend to be the nature of the quantities dealt with in quaternions and other systems of vector analysis, and of their relation to the quantities of ordinary algebra. We attempt to show that any really scientific treatment of ordinary imaginary quantities must be based on vector analysis, all imaginary and complex abstract quantities (save those of zero value) being, in fact, relations between vectors. This is, we hold, the only way to ascend, from a blind use of imaginary and complex expressions without any clear apprehension of what they denote, to a rational comprehension of the matter; in other words, from mere computation, and manipulation of symbols, to true science. We show further that the mathematicians who look upon a variable as a quantity and those who regard it as a symbol are equally in the wrong; a variable being represented by a symbol and being composed of quantities. We consider the arrangement of the quantities of a variable, and show the importance of this commonly neglected attribute. We discuss the peculiar arrangements which must be at hand to justify the application of the theory of monogenic functions, and show the relation of these multiplex arrangements (as we call them) to the arrangements of the elements of the aggregates designated by Cantor as *mehrfach geordnet.* As the simplest of variables we put forward the ordinary progressions of elementary mathematics which are not usually recognized as variables at all. We attempt to show clearly just what distinctions should be drawn between a progression and a series; and, including all progressions and all series under the head of sequences, lay down the conditions under which a variable is to be

classified as a sequence. Passing to the question of functional relation we take up independent and dependent variables, and show that these names correspond to at least three separate distinctions, a fact not ordinarily recognized by mathematicians. We give a somewhat elaborate discussion of functional relations, showing that what is ordinarily put forward as the Dirichlet definition of function does not adequately characterize a functional relation, and moreover is not really the definition given by Dirichlet. We lay down what we deem to be the conditions under which two or more variables may be said to be in functional relation with each other; and show that previous authors, in their treatment of functions, have not attained to a clear and precise view of the essential characteristics of a functional relation.

To these salient features of our work Professor Miller gives no heed whatsoever, though assuredly they comprise topics of fundamental importance in mathematics. He is content to dismiss our inquiries by stigmatizing them as relating chiefly "to definitions and the choice of words." We plead that our work is concerned chiefly with the unfolding of the conceptions which words should awaken in our minds, and not with the words themselves. To purely verbal questions we give scant attention. In our endeavors to attain to distinct and exact conceptions of what is fundamental to the inquiries of mathematics, we have found that the portrayal of these conceptions, as set forth by mathematicians of the highest eminence, are not free from great imperfections. We have spared no labor in obtaining and in stating in full "the definitions given by those who have made important advances in the fields" into which we go; and when unable to assent to these definitions, we have carefully set down our reasons for holding that they do not truly depict the lineaments of the conceptions which they purport to unfold. And Professor Miller, though manifesting his disapproval of our criticisms, makes not the slightest attempt to show that our charges of error are baseless, and that Baire, Pringsheim, Riemann, Russell, Weber, and the other authorities whom we controvert are not guilty of the errors we ascribe to them.

Three passages of our work are specifically condemned by Professor Miller. All of these are trivial and could be removed from the work without affecting any of its doctrines or any major or minor argument put forward in defense of them. One fault that is imputed to us is that "on page 177 and elsewhere, the common erroneous assumption according to which the word function was used as synonymous with power is repeated." We merely say that "the word function *is said* to have been used by the older analysts as synonymous with power." We took care to insert the qualifying phrase *is said,* and so worded our remark is neither an assumption nor an error. And no reference to this usage occurs elsewhere. We are also rebuked for saying that "The only mathematician that we recall as making a specific distinction between quotient and ratio is Hamilton." We must acknowledge that such a distinction has been made by others, but we deny that the distinction we endeavor to enforce is as common as Professor Miller would have it appear. Finally we are chided for applying to imaginary and complex quantities the distinction between positives and negatives. Yet, if precedent is to be a guide, we can plead that both Gauss and Weierstrass used the two adjectives with respect to imaginary quantities.

ROBERT P. RICHARDSON,
EDWARD H. LANDIS

QUOTATIONS

SCIENTIFIC SNOBBERY

ONE reason for the neglect of science is that scientific men themselves frequently misrepresent the objects for which they work. For example, they often pretend that they perform their labors merely for their own amusement. We once heard it wittily said of such a man that he takes out his watch before dinner and exclaims, "Ha! I have half an hour before I must dress for dinner; I will just step over to my laboratory and make a discovery." But the public is not so easily deceived and therefore thinks in its dull way that the man of

science really labors in the hope of making some enormous fortune or obtaining some great honor. On another occasion, we heard it said of a man who has been toiling for years in the tropics for nothing, that "nobody knows why he does it, but we all believe that he wants a knighthood." When we timidly suggested that he was guided merely by a sense of duty, we were met by a stare of astonishment. Certainly this worker has never received a penny for his work as yet and never will, and we fear that not even a knighthood will come his way. No, men of science do not work either for amusement or to make fortunes. Like artists and musicians, they often find their labors fascinating because nature imbues them with an instinct in the directions chosen by them; but they are also conscious that their work will bring them no personal profit—not so much as that which a tithe of the ability shown by them in science would have yielded them in politics, law or grocery. Their ultimate object is to benefit humanity by adding to the store of knowledge which lifts the civilized man so far above the savage of the jungles. And that is the greatest object which any man can keep before his eyes.

Another form of scientific snobbery is the pretense that science has no practical object in view—it is so lofty a pursuit that the man of science should live among the stars and not soil his fingers with the common earth of everyday life. Even Lord Kelvin said "that no great law in natural philosophy has ever been discovered *for* its practical application" —though no one based more patents on his own researches than did Lord Kelvin. He may have been right in one sense, but certainly not in all (and he can not be accused of any form of snobbery). Thus geometry was really founded for the purposes of architecture and navigation. Mechanics was created to assist the engineer, and the theories of heat and of the conservation of energy were probably generated by the steam-engine; while the entire science of pathology has simply been created for its practical application as regards the prevention and cure of disease. Certainly investigations which were apparently useless at the outset have often led to valuable practical applications; but they were usually undertaken because the worker knew that he must first solve general problems before applying the solution to specific cases. We believe that all the great theorists had practical applications before them like a distant light even in the greatest darkness of their efforts. Is it likely that Newton, or Harvey, or Faraday did not prophetically see that their work would some day benefit humanity? Nature is infinite, and it is therefore wise to toil in immediate contact with human needs and not to lose oneself entirely far away from the remotest utilitarian objects. In most cases those who lose all touch of the useful in their investigations end by becoming useless themselves. They are above the practical, and therefore become unpractical, and finally impossible.

Perhaps the worst form of scientific snobbery is the pretense that the man of science is absolutely above cash in any form. Let us distinguish. To effect discovery, a man must concentrate all his energies upon a single point; he has no time to watch the share market, or to promote companies in connection with his findings; and it will be lucky if he succeeds in making any advance at all even with all his energies bent upon the point of issue. In that sense, therefore, he must ignore cash. But even here various circumstances should influence him. If he is a bachelor, he may do as he pleases, and may live as a recluse upon brown bread and water in a monk's cell if he wish. But if he has children or other dependants, is he justified in allowing them to be brought up uneducated in poverty? Such a thing would not be meritorious in him but a crime; for we have our duties not only to science but to our families. The scientist who pretends his indifference to money is, therefore, often only a snob. Moreover, although he himself may have no children, or may possess independent means, this need not necessarily be the case with others. His quixotic attitude merely lowers the price of science in the world and causes other and probably better men to suffer. Still further, for the most obvious economical reasons, it causes science

in general to suffer, because when young men see the poverty of the most successful investigators they hesitate to enter such fields of labor and the recruiting of the voluntary army of science is naturally reduced. Certainly no scientific man has the smallest desire to be a millionaire; but moderate competence is useful to him as to others. A certain amount of money gives him a proper influence for good in society, and enables him to devote himself to those investigations which his nature tells him he is most capable of conducting. On the other hand, keep him in poverty and he soon loses his enthusiasm; he becomes a fakir sitting in rags by the roadside, and the ripest years of his life are often wasted. Is there any intrinsic reason why the greatest efforts of the best minds in the most fertile of fields should lead to poverty? Yet the history of the world proves that they generally do so —to the loss not only of science but of the world. And why, pray? Because when science asks for her dole, the world replies, "But those great men, Smith and Jones, are proud to labor for nothing; why then should I pay you?" Alas, poor ignorant world does not know that if Smith and Jones are genuine workers they are probably too much engrossed in their toil to bestir themselves for payment; while if, as more often happens, they are merely purveyors of others' labors, then their lofty and popular pose is adopted for a purpose. And, indeed, snobbery is often a paying cult, and those who labor for nothing do little but frequently get much!

In science as in other things, the proper and honest procedure is to pay for work done; and, to be frank, the encouragement of science, of which we hear so much nowadays, must in the end come to this—or to nothing. And in science as in other things snobbery is a false pose which brings only contempt upon those who adopt it.—*Science Progress.*

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE third number of Volume 3 of the *Proceedings of the National Academy of Sciences* contains the following articles:

The Condensation and Evaporation of Gas Molecules: Irving Langmuir, research laboratory, General Electric Company, Schenectady, N. Y. A discussion of the evaporation *vs.* the reflection theory with conclusions favoring the former.

The Ninth Satellite of Jupiter: Seth B. Nicholson, Mount Wilson Solar Observatory, Carnegie Institution of Washington. Comparison of the orbits of the Eighth and Ninth Satellites. The mean period of the Ninth is 745 days and its diameter is probably about 15 miles.

Aortic Cell Clusters in Vertebrate Embryos: H. E. Jordan, department of anatomy, University of Virginia. The hemogenic activity of embryonic endothelium is a normal function at a certain stage of embryonic development.

Rheotropism of Epinephelus Striatus Bloch: Hovey Jordan, Bermuda Biological Station for Research, Agar's Island, Bermuda. The lip region is the most sensitive part of the body surface. The end organs of tactile sensitivity serve also as organs of rheotropic sensitivity.

Studies of the Genus Phytophthora: J. Rosenbaum, Bureau of Plant Industry, Washington, D. C. A search for determining characters of diagnostic values in testing the different species.

A Possible Function of the Ions in the Electric Conductivity of Metals: Edwin H. Hall, Jefferson Physical Laboratory, Harvard University. A discussion of the number of ions necessary to maintain currents of great density, and of the temperature relations of conductivity if due to ions.

The Gravimetric Survey of the United States: William Bowie, Division of Geodesy, U. S. Coast and Geodetic Survey. A summary of the present status of the subject.

The Magnetization of Iron, Nickel, and Cobalt by Rotation and the Nature of the Magnetic Molecule: S. J. Barnett, department of physics, Ohio State University. A confirmation of the assumption that only electrons are in orbital revolution in all the substances investigated.

The Intensities of X-Rays of the L Series: David L. Webster and Harry Clark, Jefferson Physical Laboratory, Harvard University. A discussion of the intensities in the case of platinum as functions of the potentials producing them.

The Use of Vasectomized Male Mice as Indicators: C. C. Little, Harvard Medical School.

Photographic Magnitudes of Stars in the Selected Areas of Kapteyn: Frederick H. Seares, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Archaeology of Mammoth Cave and Vicinity: A Preliminary Report: N. C. Nelson, American Museum of Natural History, New York. Two isolated horizons of culture have been found; one indicating an agricultural people, the other a hunting people.

The Production in Dogs of a Pathological Condition which closely Resembles Human Pellagra: Russell H. Chittenden and Frank P. Underhill, Sheffield Laboratory of Physiological Chemistry, Yale University. The abnormal state is due to a deficiency in some essential dietary constituent or constituents presumably belonging to hitherto unrecognized but essential components of an adequate diet.

The Complete Enumeration of Triad Systems in 15 Elements: F. N. Cole, Louise D. Cummings and H. S. White. There are eighty types.

New Data on the Phosphorescence of Certain Sulphides: Edward L. Nichols, department of physics, Cornell University.

The Reactions of the Melanophores of the Horned Toad: Alfred C. Redfield, zoological laboratory of the Museum of Comparative Zoology, Harvard College.

The Coordination of the Melanophore Reactions of the Horned Toad: Alfred C. Redfield, zoological laboratory of the Museum of Comparative Zoology, Harvard College.

Petrified Coals and Their Bearing on the Problem of the Origin of Coals: Edward C. Jeffrey, botanical laboratory, Harvard University. Coals containing "coal balls" are abnormal, but there is no good evidence that "coal balls" are organized from material accumulated *in situ*.

The Effect of Degree of Injury, Level of Cut and Time within the Regenerative Cycle upon the Rate of Regeneration: Charles Zeleny, department of zoology, University of Illinois.

Preliminary Note on the Distribution of Stars with Respect to the Galactic Plane: Frederick H. Seares, Mount Wilson Solar Observatory, Carnegie Institution of Washington. A comparison of Mount Wilson counts with Kapteyn's, in which good agreement is found, as compared with both the results of Chapman and Melotte are not homogeneous.

National Research Council; Research Committees in Educational Institutions; Central Committees on Research; Reports of Meetings of the Executive Committee.

Edwin Bidwell Wilson

Massachusetts Institute of Technology,
Cambridge, Mass.

SPECIAL ARTICLES

A QUANTITATIVE METHOD OF ASCERTAINING THE MECHANISM OF GROWTH AND OF INHIBITION OF GROWTH OF DORMANT BUDS[1]

1. Each plant possesses a number of dormant buds, which may grow out when they are isolated but which remain dormant under normal conditions. The problem to be solved is the mechanism of inhibition in the latter and of growth in the former case. Former results published by the writer on *Bryophyllum calycinum*[2] indicated that both phenomena are reciprocal, inasmuch as the growth of a bud depends upon the availability of certain material, while the inhibition is due in general to the non-availability of such material, and this non-availability is frequently brought about by the absorption or withdrawal of the material by another growing organ. Thus each node of *Bryophyllum calycinum* has two leaves and in the axil of each leaf is found

[1] From the Laboratories of The Rockefeller Institute for Medical Research, New York.

[2] Loeb, J., *Bot. Gaz.*, 1915, LX., 249; 1916, LXII., 293; 1917, LXIII., 25. "The Organism as a Whole," New York, 1916, p. 153.

a dormant bud. Besides, each of the numerous notches of a leaf contains a dormant bud. None of these buds grow out into shoots in the normal life of the plant. When we cut out a piece of the stem containing a node with its two buds, remove the two leaves, and suspend it in moist air, the buds of the stem will grow out very slowly if at all. If we isolate a leaf, and suspend it in moist air, a few of its many notches will grow out into shoots. When we suspend a piece of stem with one node and with only one leaf attached in moist air the bud on the stem opposite the leaf will grow out very rapidly, but the growth of shoots in the leaf will be suppressed or very much retarded. The writer assumed that in this case substances needed for the growth of the buds in the leaf were absorbed by the stem and used for the growth of its bud; and that as a consequence the buds in the leaf were prevented from growing owing to lack of material. The writer has recently carried out a series of quantitative experiments which seem to make this theory fairly certain and a few of which shall be described in this preliminary note.

2. According to this theory, leaves of *Bryophyllum* of equal size should when isolated produce in the same time, at the same temperature and moisture, the same mass of shoots from their notches. This is only generally true when we compare leaves of different plants or of different age of the same plant. If, however, we compare the two leaves belonging to the same node of a plant (having the same size, age and history) the weight of the shoots produced by the two leaves is equal within the unavoidable limits of error of such an experiment, as the examples in Table I. show. The two leaves of a node will always be designated as *a* and *b*.

Leaves of Bryophyllum calycinum of equal size (and from the same node) produce in the same time, under identical conditions, equal masses of young shoots (although the number of shoots formed is generally different in the two leaves).

3. It followed, moreover, that if we diminish the mass of a leaf by cutting out a piece from its center while the sister leaf (from the

TABLE I

Number of Experiment		Number of Shoots Produced from Leaf	Weight of Shoots Produced in 33 Days Gm.
I.	*a*	3	0.350
	b	3	0.345
II.	*a*	1	0.290
	b	2	0.306
III.	*a*	2	0.375
	b	4	0.385
IV.	*a*	5	0.594
	b	4	0.607
V.	*a*	4	0.457
	b	5	0.455

same node) remains intact, the shoots produced by the two leaves (when isolated from the stem) should be in the ratio of the masses of the two leaves. In five leaves the center was cut out while their sister leaves were left intact. Both sets of leaves were supended in an aquarium with their apices in water. After 37 days the weight of the shoots formed in each set of leaves as well as the weight of the leaves was ascertained and it was found that each set of leaves produced shoots in proportion to its mass (Table II.).

TABLE II

Leaves Dipping in Water

	Total Weight of 5 Leaves, Gm.	Total Number of Shoots Produced	Total Weight of Shoots Produced, Gm.	Weight of Shoots Produced per Gram of Leaf in 37 Days, Mg.
Center of leaf cut out..	7.61	11	0.755	99
Leaves intact...........	13.80	9	1.405	101

The shoot production in the two sets of leaves was, therefore, within the limits of error in proportion to the mass of the leaves themselves.[3]

When the same experiment is made with leaves not dipping in water the results are not so perfect, due possibly to the fact that the leaves with their center cut out dry out more rapidly than the intact leaves (Table III.).

[3] Since the surface of the leaves is approximately proportional to the mass, we must for the present reserve the privilege of substituting the surface for weight in the expression of the numerical relation, if necessary.

TABLE III

Leaves Kept in Moist Air

	Total Weight of 5 Leaves, Gm.	Total Number of Shoots Produced	Total Weight of Shoots Produced, Gm.	Weight of Shoots Produced per Gram of Leaf in 38 Days. Mg.
Center of leaf cut out..	5.42	13	0.690	109
Leaves intact	11.81	20	1.207	102

These observations agree with the assumption that the growth of dormant buds is determined by and is in proportion to the quantity of a certain material available for the buds.

4. In the previous publications attention had been called to the fact that in an isolated leaf only a few of the numerous notches grow into shoots and this had been explained on the assumption that those notches which happen to grow out first attract all the material from the leaf and thereby prevent the other notches from growing. This suggestion was supported by the observation that if a leaf is cut into isolated pieces each possessing one notch, each notch gives rise to a new shoot (provided that the piece is not too small). The shoots in the subdivided leaf grow more slowly than the less numerous shoots of whole leaves. On the basis of our quantitative method we should therefore expect that if of two isolated sister leaves one (*a*) is left intact while the other (*b*) is cut into as many pieces as it contains notches, the ratio of the weight of shoots produced to the weight of the leaf should be equal in both leaves; in spite of the enormous difference in the number of shoots produced. If a leaf is divided into two halves *a* and *b*, and half *b* further subdivided into as many pieces as there are notches, the numerous shoots produced by the isolated notches should not weigh more than the few produced in the intact half.

These experiments encounter the difficulty that if the piece of a leaf is below a certain size its notch will fail to produce a shoot; and if the piece approaches this lower limit its shoot production is still considerably retarded so that the law of proportionality no longer holds. In spite of this and some other sources of error the results are in fair agreement with the theory.

TABLE IV

Number of Experiment	Weight of Leaf, Gm.	Number of Shoots Produced	Total Weight of Shoots Produced in 33 Days, Gm.	Weight of Shoots Produced Per Gram of Leaf Mg.
I. *a* (intact leaf).....	4.47	2	0.450	100
I. *b* (subdivided leaf).............	3.17	15	0.300	95
II. *a* (intact leaf).....	1.866	3	0.316	169
II. *b* (subdivided leaf)	1.727	14	0.345	200
Half leaves			Total Weight of Shoots Produced in 21 Days	
III. *a* (intact half of leaf)........	1.800	1	0.072	39
III. *b* (subdivided half of leaf)...	1.586	6	0.049	31
IV. *a* (intact half of leaf)..	1.062	3	0.063	59
IV. *b* (subdivided half of leaf)...	0.920	6	0.057	62

The experiments support the view that when in a leaf shoots are formed they withdraw material from the other notches and that it is this withdrawal of material which prevents the other notches from growing.

5. By the same reasoning we should expect that the inhibition in the growth of the notches of the leaf by a piece of stem (referred to in the beginning of this note) is due to the absorption of material from the leaf by the stem. In corroboration of this assumption the writer has been able to show that the inhibiting effect of the stem upon leaves of the same size increases with the mass of the stem. It has also been possible to show by quantitative experiments that the inhibiting effect of pieces of stem of the same size upon leaves of different size diminishes when the size of the leaves increases. We may say that the stem acts upon the leaf as if it reduced the size of the latter.

But the withdrawal of material by another organ is not the only way by which the growth of a bud is inhibited. The main condition for growth is that the material reaching the bud

should exceed a certain limiting quantity. If there is not enough material available or if for anatomical reasons the material can not reach a bud the latter will be prevented from growing.

6. We do not wish to discuss the nature of the substances which cause the growth, but it is important to know that the leaves will form no shoots or only very few if kept in the dark. Six pairs of leaves from the same node were suspended in moist air, one leaf of each node in the dark, one in the light. After one month the six leaves in the dark (weighing 11.65 gm.) had produced only 3 etiolized shoots weighing 0.016 gm., while the six sister leaves in the light (weighing 8.03 gm.) had produced 24 normal shoots, weighing 0.544 gm. The shoot production in the light was therefore more than thirty times as great as that in the dark. This may mean that the material from which the new shoots are produced in a leaf is itself to a large extent a product of or dependent upon the assimilatory activity of the leaf. The root formation did not seem diminished in the dark, and at first it seemed even enhanced.

JACQUES LOEB

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE 117th regular meeting of the Botanical Society of Washington was held in the assembly hall of the Cosmos Club, at 8 P.M., January 2, 1917, President T. H. Kearney presiding.

The program was devoted to the subject of Plant Introduction, under which the following papers were presented:

The Need of More Foreign Agricultural Exploration (illustrated): DR. DAVID FAIRCHILD.

Dr. Fairchild called attention to the need of more foreign exploration and to the fact that up to the present time a comparatively small amount of money had been expended on this important work. The most successful type of agricultural exploration is that carried on by men interested in particular crops. The need of studying the methods of agricultural production in foreign countries, some of the more important recent introductions, and the difficulty in getting people to adopt new foods were emphasized.

The Wild Relatives of Our Crop Plants; Their Value in Breeding; How to Secure Them (illustrated): MR. WALTER T. SWINGLE.

The usefulness of the wild relatives of our crop plants in securing such desirable qualities as hardiness, earliness or lateness of blooming or of ripening, disease resistance, extra vigor, etc., were pointed out. As an example, the desert kumquat of Australia, which does not resemble closely in general appearance true Citrus, was found to be a most desirable plant for the successful breeding of hardy and drought-resistant citrous fruits. Mr. Swingle stated that a properly digested technical knowledge of the wild relatives of our cultivated plants is an indispensable foundation for all efficient plant introduction and plant breeding.

The Introduction of Foreign Plant Diseases: MR. R. KENT BEATTIE.

Mr. Beattie separated all diseases of economic plants into two groups: (1) Those which have passed from native plants to the introduced hosts; (2) those which have been introduced, such as citrus canker and chestnut-bark disease. Diseases are brought in on diseased crop plants introduced for commercial use or for scientific purposes, or the spores may be carried in on plants not affected by the disease. Commercial-plant introductions are inspected usually by entomologists and fungus diseases are often not detected. The material imported by the U. S. Department of Agriculture undergoes rigid inspection and retention in case any diseases are suspected. During the year 1916 the Federal Horticultural Board found on the material imported by the U. S. Department of Agriculture 157 different diseases.

The Protection and Propagation of Plant Introductions: DR. B. T. GALLOWAY.

Dr. Galloway called attention to the rapid change in public sentiment in the matters of plant sanitation and hygiene and to the need of a constructive policy in adequately protecting our crop plants, and at the same time not closing the doors to the development of new crop industries. He also discussed a number of the problems confronting the Office of Seed Plant Introduction.

THE 118th regular meeting of the Botanical Society of Washington was held in the assembly hall of the Cosmos Club, at 8 P.M., February 6, 1917. Forty-four members and fourteen guests were present.

Dr. B. T. Galloway, Mr. Charles F. Deering and Professor W. D. Crocker were elected to membership.

The program of the evening was devoted to the subject of "The Relation of Plant Succession to Forestry and Grazing."

Mr. C. G. Bates discussed the natural regeneration of forest stands in the climax formations of the Rocky Mountain region and called attention especially to the temporary control of the subclimax following such a disturbance as cutting. In practical management of forests the distinct problems in kind and degree of cutting can be met by the application of an intimate knowledge of the range of conditions under which succession takes place.

Two types of succession in the forests of Oregon and Washington were described by Dr. J. V. Hoffman. The first type is dependent upon the production of seed by remaining seed trees. This type advances into an unoccupied area at the rate of 150 to 300 feet during each generation, and the resulting forest is composed of trees of unequal age. In the second type the seeds produced by the old stand retain their viability when the forest is destroyed and germinate to form a new forest of the same type and of even-aged trees.

Mr. A. W. Sampson called attention to the importance of studies of succession in the management of range lands of the Forest Service. Certain species appear early and others late in the succession which leads to the development of the climax or ultimate type. From the record of the time of appearance or disappearance of these species it is possible to determine whether the pasture is being properly or improperly used. In the latter case changes in the management can be initiated which will retain or favor the reestablishment of desirable plants.

The revegetation of badly over-grazed areas in the Santa Rita Mountain district of Arizona was discussed by Mr. E. O. Wooton. When such areas were protected small weedy annuals and annual grasses were first to enter, followed by short-lived perennial grasses, and these in turn by long-lived perennial grasses and a few species of perennial herbs and low undershrub. Fire was found to be the principal factor in preventing shrubs from replacing the grasses.

The papers were discussed by Mr. G. A. Pearson, Mr. J. T. Jardine, Dr. David Griffiths, and Dr. H. L. Shantz.

H. L. SHANTZ,
Corresponding Secretary

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 509th meeting of the society was held in the lecture room of the Carnegie Library on March 19. At this meeting Dr. Fay-Cooper Cole, of the department of anthropology, Field Museum of Natural History in Chicago, delivered a lecture on "The Pagan Tribes of the Philippines."

Dr. Cole first described the peopling of the islands, and the intermingling of peoples which has resulted in the present population. The pigmy blacks or Negritos were held to be the aboriginal inhabitants of the islands. The invading peoples are believed to have come in several waves, the earliest of which appears to have been composed of a people who were physically allied to the Polynesians. These were followed by successive invasions of primitive Malays. The effects of movements of alien peoples and beliefs was also outlined. Traces of the Hindu-Buddhist movement are evident in the folk-lore, while the great effects of the introduction of Mohammedism and Christianity are a matter of historic record.

The greater part of the evening was devoted to a description of the most fundamental facts of the religious, social and economic life of three pagan tribes—the Bagobo of southern Mindanao and the Bontoc Igorot and the Tinguian of northern Luzon. The Bagobo live on the lower slopes of Mt. Apo, in whose lofty summit a host of spirits are supposed to dwell. The people also believe in a class of powerful spirits which inhabit the realms of the earth. The Igorot and Tinguian, living in a rugged country, have terraced the mountain sides for the cultivation of rice, and have developed an elaborate system of irrigation. Until recent years both the last-named tribes have been ardent head-hunters, but the motive for taking the skull, as well as its final disposition, differ in the two districts. These tribes resemble each other in language and physical type but differ in political organization and in the construction of dwellings.

FRANCES DENSMORE,
Secretary

Errata: In making up the article on the Industrial Fellowships of the Mellon Institute, by Dr. R. F. Bacon, published in the issue for April 27, pp. 399 to 403, two errors occurred. The footnote on p. 402 should read: "The system of industrial research founded by the late Dr. Robert Kennedy Duncan was initiated at the University of Kansas, and later transferred to the University of Pittsburgh." The name of William A. Hamor, M.A., assistant director, should have been included among the officers of administration.

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SCIENCE

FRIDAY, MAY 11, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-On-Hudson, N. Y

THE MAKING OF SCIENTIFIC THEORIES[1]

THE ancient Hebrews conceived the earth to be a disk hemmed in on all sides by mountains and surmounted by the crystal dome or firmament of the "heavens." This covered disk floated upon "the waters under the earth" and from the "windows of heaven" waters were poured out upon the "thirsty earth" from another reservoir which was above the firmament. To the denizen of the humid temperature regions it is perhaps a little difficult to see how this theory could have come into existence. The rains with which he is so familiar are showers, and they suggest not so much windows in the sky as they do a ceiling with innumerable perforations or some other glorified sprinkling device. To the Children of Israel the phenomenon of showers was unknown, for the rains to which they had become accustomed both during their wanderings in the desert of Sinai and in Palestine, were of the local downpour or cloudburst type, the characteristic precipitation of the arid lands. So also their country was one in which earthquakes have been frequent, and they were not unaccustomed to seeing the earth open and water shoot upward from the fissures in much the same manner that it spurts into the hold of a ship from the opening of a seam. This oft-observed phenomenon is with little doubt responsible for the conception of the "waters under the earth" referred to in the twentieth chapter of Exodus. We see, therefore, that this crude theory of the

[1] Address of the president of the Michigan Academy of Science, delivered at the Annual Meeting in Ann Arbor, March 28, 1917.

world which was held by the early Hebrews and which appears to us so fantastic, was, after all, based upon facts, but like many theories which have followed it, upon too small a body of fact to supply a firm foundation.

It has often been said that the theories so tenaciously held by one generation are abandoned by the next. To a large extent this has been true of the past, and the explanation is in part that scientists are not less fallible than others, but are subject to like limitations in prejudice, in undue reverence for authority, in regard for the science vogue of their time, and in many other conditions. To an even greater degree the overturning of scientific doctrines has been due to the failure of both the scientists and their critics to distinguish clearly between legitimate theory within those fields where views may be rigidly tested, and audacious conjectures which have been offered under the verisimilitude of facts to explain problems whose complete solution belongs to the remote future, if they may not be regarded as insoluble by any methods which have yet been discovered.

The process of eruption within a volcanic vent as regards its physical and chemical aspects offers a problem which, though by no means simple, may yet be subjected to observation and experimentation and doubtless belongs to the realm of soluble scientific problems. The materials present at the earth's center and their peculiar state of aggregation, are by contrast very largely a subject of conjecture, and attempts to class these problems together lead to inexcusable confusion.

A theory has been defined as an explanation founded upon inferences drawn from principles which are established by evidence. By contrast the hypothesis is a supposition as yet untested. The working hypothesis of the scientist occupies an intermediate position and aims to explain, at least in part and better than any other, a set of related phenomena which are already known, and it is considered to be in a probationary stage until confirmed through rigid tests the nature of which is suggested by the hypothesis itself. When so examined it may be found wanting; but, if well founded, experimentation is likely to result in its improvement by pruning of error quite as much as through enlargement of the body of truth which it contains.

The inheritance of knowledge by the ancients was, compared to ours, small indeed; and with their limited resources in materials and in methods of investigation, even more than we, they saw "through a glass darkly." It was therefore but natural that the theories which they evolved should have been largely the product of introspective reasoning. In consequence it was in the field of mathematics that they achieved their greatest triumphs, and as an inheritance a mathematical language was common to other fields of science even late in the seventeenth century. Viewing the marvels of the universe with their limited outfit of exact knowledge, the ancient philosophers invoked the supernatural and the mysterious to explain whatever was baffling and otherwise incomprehensible. Without books the dissemination of knowledge was limited to the narrowest channels and was accomplished by the disciples of each leader of thought, who was thus under the temptation of finding an answer to all questions and founding an individual school of philosophy.

With the invasions of the barbarian Huns and the Germanic tribes in the fifth century of the Christian era, there ensued the eclipse of civilization which we are accustomed to refer to as the "Dark Ages." Out of the darkness of these centuries of intellectual stagnation we catch a glimpse which indicates that individual minds were still active in their search for the truth.

It is the twentieth day of June in the year 1320. The bells of Verona are ringing in the bright Sabbath morning and the crowd is saluting with respect a tall and serious figure—the great Dante—who with slightly bowed head is entering the chapel of Santa Helena. Dante has to-day invited the whole educated world of Verona to assemble in this chapel and listen to his discourse entitled "*De acqua et terra.*" He proposes to discuss the relative position of land and sea, and as he tells us himself, every one came at his bidding, "with the exception of a few, who feared by their presence to confirm the exceptional importance of others." . . .

With a gift for picture-writing never before equaled he has led his astounded contemporaries up to the abode of the saints and down into the depths of the lower world. Now to-day he is returning to the starting-point of his most powerful creation, to the critical examination of that which is greater than all the conceptions of poetry—the actual ordering of the universe.

Dante argued cogently for the spherical form of both the earth and the seas, and in accounting for the elevation of the land areas above the oceans, he even offered an early hint of the law of gravitation. The earth, he argued, can not elevate itself; nor can the cause be water, fire or air. He therefore suggested that the fixed stars might exercise this influence "*after the manner of magnets.*"

The new era which opened with the revival of learning after a thousand years of stagnation, was one dominated by new considerations within the realm of thought. The keynote of the period was the dominating influence of the Christian church, and for centuries all thinkers were required to make their expressions conform to the dogmas of the church of Rome. The emancipation supposed to have arrived with the Protestant Reformation was a partial one only, and complete freedom of thought was not secured until the modern period of science was ushered in in the latter half of the nineteenth century.

Living as we do when few obstacles are opposed to a full and free expression, it will be profitable to review by means of examples the position of science in the sixteenth and seventeenth centuries. In declaring his belief in the heliocentric theory of the planets which Copernicus had promulgated, Galileo in 1597 wrote cautiously to the Polish astronomer:

It explains to me the cause of many phenomena which according to the generally accepted view are entirely incomprehensible. I have assembled many arguments for combatting the latter, but I do not dare to bring them into the light of publication. I would certainly risk it if there were more men like you.

With the telescope which he invented Galileo nightly studied the heavens from his little tower in the outskirts of Florence, and to his friend he unburdened his soul in unbounded admiration for the works of his Creator. He writes:

The prohibition of science would be contrary to the Bible, which in hundreds of places teaches us how the greatness and the glory of God shine forth marvelously in all His works, and is to be read above all in the open book of the heavens. And let no one believe that the reading of the most exalted thoughts which are inscribed upon these pages is to be accomplished through merely staring up at the radiance of the stars. There are such profound secrets and such lofty conceptions that the night labors and the researches of hundreds and yet hundreds of the keenest minds, in investigations extending over thousands of years would not penetrate them, and the delight of the searching and finding endures forever.

From this revelation of intellectual exaltation in one of the greatest apostles of science of all time, it is necessary to turn to a far different scene staged in one of the dark chambers of the Inquisition, if we would correctly interpret the spirit of his age. Bowed with years and racked by the cruel torture, Galileo is seen kneeling before the crucifix and repeating in broken sentences the dictation of his persecutors:

I bow my knee before the Honorable General Inquisitors, and touching the holy gospels I do promise that I believe and in future always will believe whatever the church holds and teaches for

the truth. I was commanded by the Holy Inquisition that I should neither believe nor teach the false doctrine of the motion of the earth and the stationary attitude of the sun, because they are contrary to the Holy Scriptures. In spite of it I have written and caused to be printed a book in which I teach this cursed doctrine and have brought forth arguments in its favor. I have on this account been declared a heretic and worthy of contempt.

In order now to redeem myself in the eyes of every true Christian who with justice must hold me in contempt, I forswear and curse the errors and heresies referred to, and above all every other error and every opinion which is contrary to the teaching of the Church. Also I swear in future never either in spoken word or in writing to express anything on account of which any one could have me in like contempt, but I will, if I anywhere find or suspect heresy, reveal it at once to the Holy Tribunal.

It is not pleasant to dwell on the extreme conditions which determined the making of theories at this period and which continued for fully a hundred years beyond the time of Galileo. For advocating the Copernican doctrine Giordano Bruno was burned at the stake. More prudent, de Maillet left his theories of nature to be published only after his death and then with his name disguised as Telliamed through printing the letters in reverse order; while Scheuchzer avoided persecution by describing as a human victim of the Noachian deluge a gigantic fossil salamander, and thus became the butt of succeeding generations. Steno, "the wise Dane," through enjoying the favor of a powerful Christian prince, was more fortunate than most of his contemporaries, and has left us in his "Prodromus," one of the great scientific legacies of his age, now accessible to all through the excellent translation from the Latin by Professor Winter.

Inductive methods of reasoning came to play a larger part in the construction of theories as the control by both branches of the Christian church began to be relaxed. The feeling of relief from restraint brought, however, a reaction in what was almost an epidemic of theories characterized by a carelessness of construction and an insecurity of foundation that were surpassed only by the ardor and the vindictiveness with which they were defended. The latter half of the eighteenth and the first part of the nineteenth centuries was thus a period characterized by notable controversies in science which affected the greater part of Europe. Theories were attacked or defended with almost fanatical bitterness, the aim of the advocates of each theory being apparently less to arrive at the truth than to win in the struggle. Geologists were divided into two hostile camps over the origin of basalt; the Neptunists led by the Freiberg school of Werner in Germany claiming that it was a chemical precipitate in the ocean, and the Vulcanists who followed James Hutton of Edinburgh, and believed the rock to be a product of the earth's internal heat. National boundaries were largely broken down and some of the most pertinacious and vindictive of the Wernerians were to be found in the British Isles.

On the other hand, the Neptunists had to meet in Germany a formidable champion of vulcanism in the poet Goethe, who, like Dante five centuries earlier, had a keen interest in science. For a time the bone of contention was found in a small hill near Eger in Bohemia, known as the Kammerbühl, a hill which Goethe stoutly maintained was "a pocket edition of a volcano." He suggested a simple method by which the question might be settled, and proposed that a tunnel should be driven into the hill to its center. If the mountain was a volcano, as he believed, a plug of basalt should be found occupying its axis. A wealthy friend, Count Casper von Sternberg, undertook extensive excavations, which when completed in 1837 abundantly proved the correctness of the poet's position.

Another great controversy was waged

over the theory of the German geologist von Buch, known as the "Elevation Crater Theory," which assumed that volcanoes were pushed up in much the same manner as is the cuticle in the formation of a blister upon the body. Like the theory of the Neptunists, this doctrine was overthrown as soon as inductive methods of examination were applied to it.

Two doctrines of geology which were destined to play a large rôle in the history of science were developed in France. The "pentagonal network" theory of Elie de Beaumont furnished the age of every range of mountains from the direction of its trend referred to the cardinal points; while the cataclysmic theory of Cuvier held that the earth's history had been punctuated by great cataclysms resulting in the destruction of all life upon the globe and followed always by a recreation of new faunas and floras. These doctrines, like those emanating from Germany, were destined to succumb to the rigid tests of the observational methods.

The control of scientific theory by the Church whenever it felt that its doctrines had been invaded was, if less formal and direct, none the less potent even as late as the latter half of the nineteenth century. This became apparent so soon as attacks began to be made upon the theory of catastrophism, for this theory was regarded as harmonizing with the biblical account of the creation. The evidence for the overthrow of this doctrine had been long collecting by a group of giants in science which developed in England toward the middle of the nineteenth century and which included Darwin and Huxley, Wallace, Lyell and Hooker. In the field of geology Lyell's theory of uniformitarianism was the counterpart of evolution in the organic world.

The battle was joined in 1859 with the appearance of the "Origin of Species," and it was fortunate for the scientific world that the crisis brought to the front a Huxley who could face "such a storm of wrath and flood of contumely as might have overwhelmed a less resolute and clear-headed champion." Gifted with a clarity of thought and expression and a vigor of utterance which are without a parallel in the whole field of science, Huxley had an utter contempt for dishonesty in thinking and little patience with mere metaphysical abstractions. To his friend Kingsley in one of the most remarkable of all his writings he says:

> I have champed up all that chaff about the ego and the non-ego, about noumena and phenomena, and all the rest of it, too often not to know that in attempting even to think of these questions the human intellect flounders at once out of its depth.

He correctly gauged the nature of the struggle which was coming and to Darwin he wrote on the appearance of the "Origin of Species":

> I trust you will not allow yourself to be in any way disgusted or annoyed by the considerable abuse and misrepresentation which, unless I greatly mistake, is in store for you. Depend upon it, you have earned the lasting gratitude of all thoughtful men. And as to the curs which will bark and yelp, you must recollect that some of your friends, at any rate, are endowed with an amount of combativeness which (though you have often and justly rebuked it) may stand you in good stead. I am sharpening up my claws and beak in readiness.

It was not long before the stage was set for one of the most dramatic moments in the history of science, for the British Association for the Advancement of Science was to meet at Oxford in 1860, and it had been given out that the Bishop of Oxford had determined to "smash" Darwin. The meeting place in the medieval university building was in consequence crowded to suffocation with even the window ledges occupied by university dons keen for the excitement of the contest. By a mere accident and at the last urgent request of his friends Huxley reluctantly agreed to be present, for he

rightly believed that an appeal would be made to the emotions and to prejudice, and he feared no good could come from the scientific argument. It was the tremendous success which he here achieved that fully decided him to take up the cudgels for Darwin, and at the sacrifice of being branded as a heretic during much of his lifetime, he was destined to go down to posterity not only as the magnificent protagonist of the doctrine of evolution, but as the redoubtable champion of freedom of thought within the whole realm of science.

Of the encounter at the Oxford meeting there are a number of contemporary accounts, one of which says of the Bishop's address:

> In a light, scoffing tone, florid and fluent, he assured us that there was nothing in the idea of evolution, rock pigeons were what rock pigeons had always been. Then turning to his antagonist with a smiling insolence, he begged to know, was it through his grandfather or his grandmother that he claimed his descent from a monkey.

Huxley was sitting beside the venerable Sir Benjamin Brodie, and at this descent to personalities he struck his hand upon his knee and turning to his neighbor exclaimed, "The Lord hath delivered him into mine hands." Without at all comprehending, Sir Benjamin stared vacantly and the meaning of Huxley's words did not dawn upon him until Huxley had arrived at his famous retort. When the storm of applause which followed the Bishops's address had subsided the president called upon Huxley to reply.

> On this Mr. Huxley slowly and deliberately arose. A slight tall figure, stern and pale, very quiet and very grave, he stood before us and spoke those tremendous words—words which no one seems sure of now, nor, I think, could remember just after they were spoken, for their meaning took away our breath, though it left us in no doubt as to what it was.

There was first a calm scientific discussion of Darwin's theory after which Huxley turned to the Bishop to say:

> I asserted—and I repeat—that a man has no reason to be ashamed of having an ape for his grandfather. If there were an ancestor whom I should feel shame in recalling it would rather be a man—a man of restless and versatile intellect—who, not content with a success in his own sphere of activity, plunges into scientific questions with which he has no real acquaintance, only to obscure them by an aimless rhetoric, and distract the attention of his hearers from the real point at issue by eloquent digressions and skilled appeals to religious prejudice.

"No one doubted his meaning, and the effect was tremendous. One lady fainted and had to be carried out; I, for one," says the chronicler, "jumped out of my seat."

If the emancipation of science from coercion or restraint from without had arrived with the final triumph of the doctrine of evolution, can it be truly said that theories are constructed even in this generation as the result of a process of wholly untrammeled reasoning; or, on the other hand, is it the fact that with the frailties inherent in human nature they still embody elements of weakness which are due either to the deficiencies in training of their authors, to prejudices or bias conditioned upon time or place, or to some other cause?

It is usually considered to be the special function of a president to recount in his address in particular the great triumphs of science, and to touch but lightly, if at all, upon any less encouraging aspects of his science. I propose in the time that remains to me to pursue a somewhat different course, and by the use of examples selected from the field of my own special studies to discuss what may perhaps be called the psychology of theories and the conditions which determine their acceptance.

To some extent it is inevitable that theories should reflect the individuality or the environment of their authors. This is

particularly true in the field of natural science, where the laboratory is the world itself, a portion only of which can be brought under the observation of any one individual. Geological processes are different both in degree and in kind according as they are studied under conditions of aridity or of excessive humidity, under tropic heat or polar cold. It is unquestionable that geology having developed as a science in those temperate regions of moderate humidity which have permitted a high degree of civilization, is correspondingly defective, and must be modified if it is to be universal in its scope. The physical geology of deserts has been studied seriously only during the present generation. It is within the last decade only that the attention of geologists has been focused upon the subpolar latitudes, and the geology of the tropical jungles is yet to be written.

To indicate how the peculiar environment, the conditions of the time, and the special activities of the individual have left their impress upon a well-known theory, I may cite the case of Robert Mallet and his centrum theory of earthquakes, a theory which received general acceptation and was orthodox doctrine among earthquake specialists for full half a century. Robert Mallet was educated as a civil engineer, and in 1831 became a partner with his father in the foundry industry at Dublin. During the Crimean War he constructed monster mortars of thirty-six inch caliber which embodied new ideas and were completed in 1854. Thus becoming interested in ballistics, he made a thorough investigation of the strains developed by explosions in the chambers of guns, and a monograph upon the subject which he published in 1856 brought him general recognition and many honors. A year later, in 1857, occurred the great earthquake in the Basilicata, generally referred to as the "Great Neapolitan Earthquake," since the district was included in the former kingdom of Naples. Believing himself by reason of his studies of explosives to be specially fitted to investigate this disturbance, Mallet applied to the Royal Society for a grant of money, and his request being approved, he visited the Basilicata, and in 1862 in two sumptuous volumes the earthquake was explained as the result of an explosion that had occurred in a cavity beneath the region affected, the damage upon the surface being explained under the laws of transmission of stress such as had applied in his earlier researches upon cannon. No one familiar with these circumstances can reasonably doubt that the trend of his theory was already determined by his life history before his sailing from England. It should be added that through giving to the problem of earthquakes a mathematical treatment, Mallet's study had the effect of removing seismology from the field of geology for the period of nearly half a century, and giving it over to the elasticians.

It has not been altogether uncommon for students of science, and even those of the highest rank, when drawing conclusions, to fail to take proper account of the fact that the observed rates of change, or gradients, perhaps of temperature or pressure, which they have been able to verify for limited distances only, may not be assumed to continue indefinitely without interruption or variation. No less distinguished a physicist than Helmholtz on the basis of the known aero-thermic gradient as determined over Europe to a height of about nine kilometers, declared that the atmosphere could not extend beyond twenty-seven or twenty eight kilometers from the earth's surface, since the absolute zero of temperature would be reached at that level. Sounding of the atmosphere has since been carried to fully twice the limit fixed by Helmholtz,

and has revealed the fact that a few kilometers beyond the limit of exploration when he made his prediction, or at an average altitude of eleven kilometers, the aero-thermic gradient is interrupted and succeeded by practically isothermal conditions above.

To-day in reputable treatises one may read in round numbers the supposed temperature at the center of the earth, and based upon what? The geothermic gradient determined for the shell of rock immediately beneath the earth's surface and verified roughly for about one four-thousandths of the entire distance to the earth's center. Can we assume that our yard-stick in this instance is suitable for measurement throughout the entire radial distance, and is there no possibility of abrupt interruptions such as occur in the temperature gradient of the atmosphere?

William Ferrel, much the most distinguished meteorologist that America has produced, and the one to whom we owe the basic principle upon which modern meteorology is founded, predicted as a corollary to his theory of the winds the existence of whirls about the earth's geographic poles surrounding areas of calm and low atmospheric pressure. As these polar calms and whirls are an important feature of the present theory of atmospheric circulation, it will be profitable to examine briefly their evolution as a study in the psychology of theory. In the preface to his general treatise upon the winds, Ferrel tells us how his attention was first directed to this subject through reading Maury's "Physical Geography of the Sea," the first edition of which appeared in 1855, while the first essay of Ferrel was published in 1856. From Maury Ferrel learned, as he has told us, "that the pressure of the atmosphere is less both at the poles and at the equator of the earth than it is over two belts extending around the globe about the parallels of 30° north and south of the equator." On making reference to Maury, we find that upon the basis of recorded observations between the parallels of 40° and 54° south latitude the average barometer reading varies from 29.9 to 29.4 in passing from the lower to the higher latitude. With the gradient obtained from this limited range, Maury has extended the curve as a straight line to the geographic pole through a range of thirty-four degrees of latitude or more than twice the observed distance, and obtained a theoretical reading for the pole of twenty-eight inches of mercury. A similar method applied to the northern polar region has supplied a less marked gradient and a theoretic value for the barometer reading at the northern geographic pole of 29.65 inches of mercury.

Since this theory was promulgated, exploration has been extended to both poles of the earth and has shown that but a short distance beyond the latitudes which limited the data employed by Ferrel, the steadily lowering pressure gives place to a rising barometer in the direction of the poles. Studies of the free atmosphere by means of balloons in the same high latitudes also indicate pretty clearly that no such whirls as Ferrel assumed can exist. Yet so great has been the success of Ferrel's theory as a whole that despite their contradiction by the facts, the polar calms and whirls are still treated in the latest text-books of meteorology.

The polar whirls of Ferrel are by no means a unique example of a large conception in science receiving general support because however carelessly constructed it was an attachment or rider to a still larger theory. The triumph of the larger idea or the prestige of the author due to some other achievement, has by its inertia

carried the smaller conception to general acceptance.

So fundamental a theory as that of Laplace to explain the origin of the universe, a theory which has been standard doctrine for more than a century and is only now being replaced as a result of rigidly applied tests, appears never to have been very seriously considered by its author, but was thrown off as a brief appendix or postscript to a general work on astronomy. It has the curious title "Note VII. and Last" and Laplace says of it that the hypothesis must be received "with the distrust with which everything should be regarded that is not the result of observation or calculation." Moreover, so far as known, Laplace never subjected the theory to the test of well-known mathematical principles which were involved, although this was his usual habit. The success and general acceptance of the theory seem to have been due to the altogether remarkable prestige of its author as the greatest mathematician since Newton, and as the author of the "Mécanique Céleste," a work which has never been rivaled in its field, and of which it has been said that any one of its twenty-four parts would have made the reputation of a man of science.

Though primarily a theory of the origin of the universe and thus in the realm of astronomy, Laplace's nebular hypothesis left its impress upon geology and particularly upon geophysics, in that it gave continued standing and scientific respectability to the notion that the earth has a liquid interior. It would be somewhat difficult to trace the origin of this belief, which naturally grew up from the observations of volcanic eruptions—no uncommon event in the Grecian Archipelago and in Italy, the regions where science had its beginnings. After the studies of combustion had exploded the notion of "internal fires," the theory took the form which it has retained to our day, little affected at first by the proofs of earth rigidity which were brought forward by Kelvin. With little doubt the associated idea of a congealed crust floating upon a liquid interior is based upon the analogy with the winter cover of ice which forms over our lakes and rivers. This analogy supplies, therefore, a striking instance of the influence of climate in giving complexion to a fundamental theory, and the fact that rock, unlike water, is heavier in the solid than in the liquid state, is a very recent discovery. Save for its intimate relation to Laplace's theory, the conception of the liquid core to the earth must have long since been relegated to the limbo of exploded doctrines, to the great benefit of more than one of the physical sciences.

It would be easy to show that well-known scientific theories have embodied fatal defects, in that assumptions of vital importance have been introduced quite unconsciously by their authors. I have believed, and have elsewhere attempted to show, that the Pratt-Hayford theory of isostatic compensation, which assumes for every mountain a necessary defect of mass directly below, and for the column below every depression of the earth's surface a corresponding excess of mass; that this theory has been set up without due regard to the dominating effect of any hidden masses of unusually high density which may lie near the observing station. This view seems now to have found confirmation in recent studies carried out by the United States Coast and Geodetic Survey. I may perhaps best illustrate what is here meant by the use of an example taken from a related field of study. If one should ascribe the strong magnetic attraction which is exercised by local masses of iron ore in the Northern Peninsula of Michigan to the effect of such

an extended system of smaller masses distributed throughout a large district, as might produce the same effect at a given station, the error would be of the same nature as that which must result from ignoring the effect at the gravity stations of any local and very dense masses which may be hidden beneath the surface.

Does prejudice, either national or racial, ever influence the thinking of men of science? I ask you to look back over the history of the past two and a half years and for the answer examine some of the statements which have been signed by men who were counted among the master scientists of their generation. These sweeping statements were many of them false; and if not known to be by those who subscribed to them, it is clear that an unbiased inquiry must either have revealed the truth or have indicated the necessity for withholding a verdict. This *débâcle* of science which came at the outbreak of the present war is one not easily to be retrieved.

If I have succeeded in my endeavor, I have shown that scientific theories as they are constructed even to-day with the aid of all modern equipment and inheritance, may contain fatal elements of weakness though they be promulgated by scientific men of the highest rank and attainments. Fortunately the student of science to-day enjoys an independence which was never vouchsafed him in the past, when the learner was by the conditions under which he studied an advocate of the doctrines of his master. There are to-day no dictators in science such as were Werner in Germany, de Beaumont in France, Murchison in England, or Agassiz, the "pope of American science." For what he accepts and teaches the student of science is to-day responsible, and it devolves upon him not merely to examine each theory as regards its inherent plausibility and the degree to which it has been confirmed, but to inquire also into the human and other factors which have entered into it or which have accounted for its acceptance into the body of doctrine of science.

It has seemed to me that the excessive stress which in our science training we now lay upon the careful balancing of evidence, has in a measure taken away our capacity for making decisions. The cult of being open-minded has been elevated into a fetich, with the result that the really vital considerations are often hopelessly entangled with non-essentials. A little reflection must show that upon the principle of chances the weight of evidence in the case of but few problems can be evenly balanced; but a clever exaggeration of the non-essentials seldom fails to raise serious doubts in the minds of a considerable proportion of those considered qualified to reach a decision. Why, if this be not so, have so many of our highly trained scholars failed to see that the events which are now transpiring have long been clearly foreshadowed, and were inevitable results of observed conditions in a world controlled by natural laws. This is due to a lack of vision—of prescience—which above all is dependent upon first clearing away from a question the rubbish which has accumulated about it, and then focusing the attention unerringly upon the heart of the problem.

Lack of vision largely explains the great inertia of science which causes the retention of useless or harmful theories long after their inadequacy or falsity has been exposed, and this inertia is greatly aggravated by potent accessory influences. Any successful theory which occupies a basic position in science, is sure to be built upon as a foundation for other theories, and these are likely to crumble with its collapse. Much money and labor are now invested in treatises and popular works, the income

from which becomes seriously affected whenever their reliability is brought into question. The ultra-conservative attitude of scientists which results from these and other causes is as obvious as it is deplorable.

As we look back over the past and, studying the advances of science, mark off upon the way the stations at each of which a new horizon has opened, it is easy to see that the successive marches, like the halts between, have been far too long. The attempt to reproduce from each station the entire panorama of the horizon has led to a sketchiness and an inaccuracy in the depicting of all remoter portions of the field, which might have been avoided had the viewpoint been promptly moved forward so soon as the nature of the nearer terrane had become firmly established. My appeal is, therefore, for an individual study of those theories of science with which each worker is concerned, and for an early decision upon their availability whenever a judgment is warranted. Accepted, if necessary, as working hypotheses to be rigidly tested by observation and experiment, the new ideas are infinitely to be preferred to those theories which have been found wanting under the tests either of experiment or of searching observation.

It might perhaps be asserted that the picture which I have drawn of the past and present of scientific theories is one not calculated to cause entire satisfaction; and I could hardly deny the truth of the assertion; but when, I would ask, has either an institution or an individual been other than benefited through a searching self-examination? Even the shock to our self-pride which came with the revelations of this bellum period is not fraught with permanent disaster. Since the condition existed, it is far better that we should know it, and so far as may be possible provide against its recurrence in the future.

The encouraging feature of our entire survey is the evidence which it shows of a steady evolution toward better conditions; for no one can truthfully deny that the scientific world is to-day in a far better position than it has ever occupied in the past; and the outlook for the future is so much the more encouraging.

William H. Hobbs
University of Michigan

HERBERT W. CONN

It has been said of America that it is peculiarly able to produce the right man at the right time when emergency calls. Herbert W. Conn was not only a cultivated scientist, but a personality, because he embodied in himself the initiation of a great movement in America. The science of bacteriology as developed in Europe through Pasteur and Koch attracted his attention in the early years of his education, and led him to feel that this science had a great function to perform in connection with milk and dairy products in America. In the early eighties his pioneer work was begun in milk bacteriology and was developed in his laboratory in Wesleyan University, and under his supervision in Storrs Agricultural Experiment Station, Connecticut. Whatever lines of influence have been developed through later years in the improvement of municipal milk supplies and in the improvement of sanitary conditions on dairy farms, when traced back to their sources, will show a connection with and a stimulation from the early milk bacteriology of Herbert W. Conn. He took part in the councils of those who established the certified milk industry, and assisted in framing the regulations which were first drawn up in the early nineties for the control of certified dairies. He suggested the production of sanitary butter through the pasteurization of cream, and the use of pure cultures of lactic acid bacteria. He was among the first to show the close relationship between unsanitary con-

ditions on dairy farms and the numbers and species of bacteria found in milk. The examination of municipal milk supplies for bacteria was directly stimulated by his work in showing the relationship of bacteria to the sanitary character of milk.

He was the founder and first president of the American Society of Bacteriologists. He was for many years a very active member of the American Public Health Association. During his latter years he became closely identified with the work of the New York Milk Committee as a member of the commission on milk standards appointed by that committee. While this commission was composed of twenty of the men most prominently identified with the improvement of municipal milk supplies in the United States and Canada, no member of the commission was more interested in its work or devoted more time to the same than Professor Conn. Through the work of this commission he recognized that many of the principles which for years he had been advocating could be put into practical operation. Among these he was most interested in the establishment of uniform laws and regulations for the control of public milk supplies through state and municipal authorities.

While Professor Conn's name will always be more closely identified with milk sanitation than with any other single subject, his work covered a much broader field. He was the author of numerous pamphlets and books on subjects related to biology and bacteriology. His textbooks on elementary bacteriology, hygiene and physiology are widely used by the public schools throughout the United States. His books on evolution were the first to put in clear and popular language the more important features of the philosophy of Spencer and Darwin and the modern theories on this same subject. His position as director of the laboratories of the State Board of Health of Connecticut, which he occupied during his latter years, brought him into contact with every phase of public-health work. He became identified in this way with the improvement of the sanitary condition of water supplies in the state of Connecticut, and with the supervision of oyster beds. His knowledge and experience in the bacteriology not only of milk but of these other subjects led to his appointment as a member of the committees appointed to establish standard methods for the laboratory examinations and sanitary standards for their control.

As a man, he was always genial and easy to approach, and ready to give freely of his time for the discussion of public-health work. His many scientific associates recognized in him one who could be always relied upon to carry out more than his share of any work assigned to him. This activity he preserved to the last. His high personal standards of integrity and conscientiousness led him to be an ardent advocate of higher professional standards in public-health work, and to take an active part in the movement recently organized to secure fuller recognition of public-health service as a profession. The last work in which he took part before his death was as a member of the council of the newly organized American Academy of Public Health. His death was sudden and entirely unexpected not only by his associates, but by his immediate family. His personality and his numerous activities will make his loss deeply felt by the many organizations and scientific men with whom he has been associated. While carried away with his work still incomplete, he leaves behind him work already accomplished of such great importance not only to science, but to humanity, that it is a contribution that will endure.

C. E. N.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORT OF THE COMMITTEE ON GRANTS FOR RESEARCH

By the settlement of the Colburn estate in 1916 the American Association for the Advancement of Science received cash and securities valued at about $76,000, bequeathed by Richard T. Colburn, a fellow of the association, the income of which is to be devoted "to original research in the physical and psychic

demonstrable sciences." The association had accumulated a fund of about $25,000, mainly from the fees of fellows, life members and members. The income from these funds being available for grants for research, the sum of $4,000 was, at the New York meeting of the association, on the recommendation of the treasurer, set aside for this purpose by the council, to be expended during the year 1917. The following committee on Grants for Research was at the same time appointed: E. C. Pickering, astronomy and mathematics, *chairman;* Henry Crew, physics; E. C. Franklin, chemistry; R. T. Chamberlin, geology and geography; W. B. Cannon, zoological sciences; N. L. Britton, botanical sciences; J. McKeen Cattell, psychology and anthropology, *secretary.*

This committee, after a considerable amount of correspondence, met in Washington on April 15 and 16, there being present Messrs. Pickering, Cannon, Crew and Cattell; Mr. R. A. Harper was present to represent Mr. Britton for grants in botany. The following general rules of procedure were adopted, based on the report of the committee on the Colburn and other research funds, presented by Mr. Pickering to the committee on policy at its meeting in New York on September 30, 1916:

1. Applications for grants may be made to the member of the committee representing the science in which the work falls or to the chairman or secretary of the committee. The committee will not depend upon applications, but will make inquiry as to the way in which research funds can be best expended to promote the advancement of science. In such inquiry the committee hopes to have the cooperation of scientific men and especially of the sectional committees of the association and of the subcommittees of the Committee of One Hundred on Research of the association.

2. The committee will meet at the time of the annual meeting of the association or on the call of the chairman. Business may be transacted and grants may be made by correspondence. In such cases the rules of procedure formulated by Mr. Pickering and printed in the issue of SCIENCE for May 23, 1913, will be followed.

3. Grants may be made to residents of any country, but preference will be given to residents of America.

4. Grants of sums of $500 or less are favored, but larger appropriations may be made. In some cases appropriations may be guaranteed for several years in advance.

5. Grants as a rule will be made for work which could not be done or would be very difficult to do without the grant. A grant will not ordinarily be made to defray living expenses.

6. The committee will not undertake to supervise in any way the work done by those who receive the grants. Unless otherwise provided, any apparatus or materials purchased will be the property of the individual receiving the grant.

7. No restriction is made as to publication, but the recipient of the grant should in the publication of his work acknowledge the aid given by the fund.

8. The recipient of the grant is expected to make to the secretary of the committee a report in December of each year while the work is in progress and a final report when the work is completed and published. Each report should be accompanied by a financial statement of expenditures, with vouchers for the larger items when these can be supplied without difficulty.

9. The purposes for which grants are made and the grounds for making them will be published.

At the meetings of the committee held in Washington on April 15 and 16, 1917, the following grants were made:

ASTRONOMY

Five hundred dollars to Professor Philip Fox, of Evanston, Illinois, for the measurement and reduction of the photographic plates taken at the Dearborn Observatory for determining stellar parallax.

PHYSICS

One hundred dollars to Professor F. C. Blake, of Ohio State University, in aid of his well-known work on electric waves. The particular problem which Professor Blake has in hand is to determine how the capacity of an air condenser, consisting of a pair of circular plates, varies with the distance separating the plates. The frequency of the current used is of the order of one hundred million alternations per second. The distance separating the plates is varied from a small fraction of the radius to more than four times the radius.

Three hundred dollars to Professor Richard C. Tolman, of the University of Illinois, for further testing and extending his already published work on the E.M.F. produced in a conductor subjected to mechanical acceleration. The problem is essen-

tially the converse of the one by which Maxwell tried in vain to exhibit the inertia of electricity—of, as we now say, the mass of electrons. Professor Tolman has devised a simpler and more promising method than that which he previously employed for producing the acceleration of the wire.

GEOLOGY

Three hundred dollars to Professor Herman L. Fairchild, of the University of Rochester, to defray traveling expenses in a study of the Postglacial land uplift in New England and the maritime provinces of Canada. Professor Fairchild has already determined the amount of Postglacial uplift in New York and the western part of New England. The results are well shown on the maps submitted. It seems very desirable to extend this important survey eastward across New England and the maritime provinces, and so complete the study across this very significant and possibly critical region. The diastrophic movements connected with the withdrawal of the last ice-sheet, when better understood, are likely to throw much light upon the much larger problem of earth deformation, which is one of the greatest problems now confronting the philosophical geologist. A continuation of this work by Professor Fairchild is likely to prove an important contribution both to Post-Pleistocene geology and also to dynamic geology.

One hundred dollars to Professor Samuel W. Williston, of the University of Chicago, toward the expenses of an artist to help draw the figures of the many new Permian fossil vertebrates which Dr. Williston has discovered and is now describing. Professor Williston has been obliged to draw himself practically all of the numerous figures which illustrate his very important publications. This consumes much very valuable time which might otherwise be employed to far better purpose.

One hundred dollars to Mr. Ralph W. Chaney, advanced graduate student, University of Chicago, toward field expenses of further studies upon a radically new ecological problem presented by the Eagle Creek flora of the Columbia River gorge. As a result of last summer's field work in this portion of Oregon, Mr. Chaney has happened upon a new method for determining the past topography and physiography of a region, based on plant ecology. Its essential features are these: Leaves of two distinct types, the one representing a xerophytic plant association and the other a mesophytic, are found intimately mixed in the same strata. It is not possible to conceive of these having grown together in the same habitat, for their moisture requirements are too widely different. The conclusion is that the xerophytes reflect the nature of the climate of the upland country while the mesophytes in a region with such a climate must have been limited to narrow and deep valleys into which the direct rays of the sun did not penetrate and where, as a result, humid conditions existed.

PATHOLOGY

Five hundred dollars to Professor Frederic P. Gay, of the University of California, for animals and materials to be used by Dr. Takeoka, in the study of the specific treatment of tuberculosis in animals, especially in the use of taurine derived from the muscles of certain shell fish. By the use of this animo acid of bile Dr. Takeoka has been able to cause tuberculous lesions in guinea pigs and rabbits to disappear completely. Taurine being a normal constituent of the body and proving harmless when given intravenously, is now being used cautiously in the treatment of human beings.

BOTANY

Two hundred and fifty dollars to Professor Herbert M. Richards, Barnard College, Columbia University, for the continuation of the investigation of the physiology of succulent plants. The grant is to be used, partly in carrying on experiments at Carmel, California, where the plants are under investigation, partly in purchasing new apparatus and partly in employing assistants, in whatever proportion seems most profitable for the production of results.

One hundred dollars to R. C. Benedict, Brooklyn Botanic Garden, for the continuation of the investigation on the Boston fern. This grant is recommended by the sectional committee of Section G of the association.

One hundred dollars to Professor C. H. Kauffmann, of the University of Michigan, to aid in his studies of the fungus genus *Cortinarius*. The grant is to be used for field explorations in the Rocky Mountains, it being necessary to study there the genus, which is a large and difficult one with evanescent characters.

PSYCHOLOGY

One hundred dollars to Professor J. B. Watson toward the study of the development of the reflexes and instincts of infants. Dr. Watson, who is professor of psychology in the Johns Hopkins University, has done important work on animal behavior and the psychology of conduct. The obstet-

rical ward of the Johns Hopkins University Hospital is adjacent to his laboratory, and about forty newborn infants a month are available for study. The hospital is prepared to cooperate in the work but will not pay the expenses connected with it. No systematic study of the development of infants has hitherto been made under laboratory conditions.

One hundred dollars to Professor R. S. Woodworth for compiling anthropometric data. Dr. Woodworth, who is professor of psychology in Columbia University, had charge of an anthropometric laboratory at the St. Louis Exposition. Many physical, psychophysical and mental measurements were made of the savage and semi-civilized peoples who were assembled at the exposition, as well as of ordinary visitors. Parts of the data have been compiled and published, but there remains a large part of the material that it has not been possible to collate, owing to the fact that our psychological laboratories do not have means to pay the expenses of computation.

One hundred dollars to Professor Robert M. Yerkes toward the cost of apparatus and care of animals in the study of animal behavior. Dr. Yerkes, who is assistant professor of psychology at Harvard University and is this year president of the American Psychological Association, has made many original contributions to animal psychology as well as in other directions, and wishes during the summer to study the alleged ideational behavior of the horse. While extraordinary performances of trained horses have been published and have attracted wide attention, the work has not been done under experimental conditions. The construction of apparatus and the care of animals is expensive and can not be met by the ordinary laboratory appropriation.

ANTHROPOLOGY

One hundred dollars to Dr. A. Hrdlička for anthropometrical investigations on the tribe of Shawnee in Oklahoma. Dr. Hrdlička, who is curator of physical anthropology in the United States National Museum and one of our ablest physical anthropologists, could with advantage carry on these investigations and the work is pressing, as the tribe, so far as pure bloods are concerned, is becoming rapidly extinct.

One hundred dollars to Dr. Benno Oetteking, now working at the American Museum of Natural History, for the purpose of completing the investigation of skeletal material from the Pacific coast of America. The assistance needed is required for the tabulation and reduction of measurements. This grant is recommended by Professor Franz Boas, chairman of the subcommittee on anthropology of the Committee of One Hundred.

GENERAL

Two hundred dollars to the Pacific Coast Subcommittee of the Committee of One Hundred on Scientific Research, of which Professor J. C. Merriam, of the University of California, is chairman. The grant is to be used for printing, postage and clerical work in connection with an investigation to secure organized information relative to research on the Pacific coast. It is planned to secure from each investigator a brief statement of his training, accomplishment, plans for work and needs for supporting the investigation in progress or projected. The work is being done in cooperation with the scientific organizations of the Pacific coast and the committee of the National Research Council on a census of the scientific resources of the United States.

J. McKEEN CATTELL,
Secretary

SCIENTIFIC EVENTS

THE CARNEGIE EXPEDITION FOR THE STUDY OF CORAL REEFS

PROFESSOR L. R. CARY and Dr. Alfred G. Mayer, members of the Carnegie Institution expedition to study the coral reefs of Tutuila, Samoa, have returned.

It was found that the surface water at the equator is cooler and less alkaline than that 5° or 10° north or south.

Also equatorial counter currents against the prevailing westerly drift of the tropical Pacific were generally places where the water is relatively acid, thus suggesting that they may occur in regions wherein the cold deep water comes to the surface.

The rain-water of Samoa is acid, of the order 10^{-5}, but the streams and springs of both Samoa and Hawaii are alkaline, having a hydrogen ion concentration of 10^{-7}. Thus the reefs can not be dissolved by the "acidity" of the outflowing waters, and the Murray-Agassiz solution-theory fails to account for the origin of barrier reefs. On the other hand, scouring due to currents, and to the activity of holothurians are important factors.

Observations upon *Alcyonaria* and stony

corals were conducted to determine their growth-rate, and the share they take in the composition of reef limestones. A statistical ecologic study of the reefs was made, and the reactions of corals to heat and salinity determined.

COMMITTEES UNDER THE BRITISH BOARDS OF TRADE AND AGRICULTURE

The president of the Board of Trade has appointed a committee to consider and report what steps should be taken, whether by legislation or otherwise, to ensure that there shall be an adequate and economical supply of electric power for all classes of consumers in the United Kingdom, particularly industries which depend upon a cheap supply of power for their development. The members of the committee are: Mr. F. Huth-Jackson (chairman), Mr. H. Booth, Mr. J. Devonshire, Mr. J. Falconer, Mr. G. H. Hume, Mr. J. Kemp, Mr. H. H. Law, Mr. C. H. Merz, Sir Charles Parsons, Sir John Snell, Alderman C. F. Spencer and Mr. A. J. Walter.

The president of the Board of Agriculture and Fisheries has appointed a committee to consider practical means for increasing the supplies of sea-fish for the home markets and for encouraging the consumption of such fish, whether cured or fresh, in substitution for other foods. The committee has received a grant from the development fund, with authority to expend the grant, subject to limitations and conditions recommended by the development commissioners and approved by the treasury, at their discretion for the increase of the fishing power of vessels other than steam fishing vessels. In general their expenditure will be confined to assisting fishermen who are owners of their own boats to develop their fishing power and to secure greater quantities of fish. The committee consists of: Mr. Cecil Harmsworth (chairman); Mr. H. S. M. Blundell, of the Admiralty War Staff (Trade Division); Mr. H. G. Maurice, of the Board of Agriculture and Fisheries; Mr. E. H. Collingwood, of the Board of Agriculture and Fisheries; Mr. Stephen Reynolds, representing the Development Commissioners; Mr. A. Towle, representing the Food Controller.

The president of the Board of Agriculture and Fisheries has appointed a committee to consider whether any considerable addition to the home food supplies of fish could be provided from the rivers, lakes and ponds of England and Wales. The committee is requested to have special regard to considerations affecting the practicability of any scheme for bringing fresh-water fish supplies into consumption, such as transport to market, the food value of the different kinds of fish, the probability of its proving acceptable to the consumer, the necessity for interference with private rights, and the risk of damage to more valuable fisheries. Further, the committee will consider and report upon measures which might be taken for securing a greater output of eels from the waters of the United Kingdom for home consumption. The members of the committee are: Lord Desborough (chairman), Mr. R. B. Marston, Mr. A. R. Peart, Mr. F. G. Richmond, Mr. H. T. Sheringham, Mr. A. Tate Regan, Sir John Wrench Towse. The Hon. A. S. Northcote will act as secretary to the committee.

BASE HOSPITALS ABROAD

Six of the base hospitals organized by the American National Red Cross for service with the medical department of the United States Army have been ordered abroad for active duty. The hospitals are: Base hospital No. 2, the Presbyterian Hospital, New York, Dr. George E. Brewer, director; base hospital No. 4, the Lakeside Hospital, Cleveland, Dr. George W. Crile, director; base hospital No. 5, Harvard University, the Peter Bent Brigham Hospital, Dr. Harvey Cushing, director; base hospital No. 10, the Pennsylvania Hospital, Philadelphia, Dr. Richard H. Harte, director; base hospital No. 12, Northwestern University Medical School, Dr. Frederick A. Beasley, director; base hospital No. 21, Washington University Medical School, St. Louis, Dr. Frederick T. Murphy, director. Three of the units are expected to embark at once and the others to follow soon.

The Harvard University unit includes the following:

Majors—Robert U. Patterson, Medical Corps, U. S. Army, commanding officer; Harvey Cushing, director; Richard P. Strong (absent in Europe), chief laboratory section; Roger I. Lee, chief medical section; Robert B. Osgood, chief surgical section.

Captains—Daniel F. Harmon, Medical Corps, U. S. A., Adjutant; Walter B. Cannon; Reginald Fitz; George S. Derby; Walter A. Boothby; Edward B. Towne; Charles Rund, Jr., quartermaster, O. R. C., U. S. Army; Percy Browne, Horace Binney, Elliot Cutler, Henry Lyman.

Lieutenants—George P. Denny, Gilbert Horrax, Frank R. Ober, John J. Morton, Oswald H. Robertson, Thomas R. Goethals, Samuel C. Harvey, James L. Stoddard, Henry Forbes, A. V. Bock.

Dental Surgeons (*Lieutenants*)—William Potter, Harrison L. Parker.

Those with the Presbyterian Hospital and Columbia University unit include: Drs. George Emerson Brewer, Homer Swift, William Darrach, Sidney R. Burnap, Fordyce B. St. John, Alex McCreery, John A. Peters, Benjamin R. Allison, William F. Cunningham, William Barclay Parsons, Robert Kennedy, William C. Woolsey, Gerhard Cocks, Armitage Whitman, Willard B. Soper, Louis Casamajor, Alwin M. Pappenheim, A. R. Stevens, Roderick Grace, Austin Hobbs, Malcolm McBurney, Henry S. Dunning and E. H. Raymond.

The Mayo Foundation of the University of Minnesota has offered the government for foreign service a fully equipped field hospital unit, headed probably by Dr. William J. Mayo. The organization is known as the University of Minnesota Field Hospital Unit and has 500 tented beds of the latest model, full surgical apparatus and a portable shelter for an operating room. Dr. E. H. Plummer, Dr. Charles Judd, Dr. Frank C. Todd, Dr. H. Robertson and Dr. S. Marx White are among the medical men who have enrolled.

After the conference of the medical board of the Council of National Defense with Colonel T. H. Goodwin, of the Royal Army Medical Corps, in Washington, D. C., on April 29, it was announced that plans had been made to send one thousand American surgeons to Europe for service with the allied armies. This offer came from the American College of Surgeons. The deans of forty-six medical schools met in conference with the general medical board and agreed to continue instruction without shortening the courses so as to furnish new graduates. Both the schools and the hospitals, however, will cut down in the number of men on the staff as much as possible so as to set them free for service in the army.

SCIENTIFIC NOTES AND NEWS

At the recent meeting of the National Academy of Sciences, Dr. Charles D. Walcott, secretary of the Smithsonian Institution, was elected president, in succession to Professor William H. Welch, of the Johns Hopkins University. To fill the vacancy in the secretaryship, caused by Dr. Walcott's election to the presidency, Dr. A. A. Michelson, of the University of Chicago, was elected.

The Franklin Medal awarded by the Franklin Institute to Dr. M. A. Lorentz, professor of mathematical physics at Leiden, will be received by the minister from Holland at a meeting on May 16. A Franklin medal will also at the time be presented to Admiral D. W. Taylor, chief constructor of the United States Navy, who will make an address on "The Science of Naval Architecture."

On May 3 of each year the Howard Taylor Ricketts prize for research by students in the departments of pathology and bacteriology and hygiene, in the University of Chicago, is awarded by the university, this being the anniversary of the death of Dr. Ricketts from typhus fever acquired by him while investigating that disease in Mexico City. The prize this year is awarded to Mr. Enrique E. Ecker, for his work entitled, "The Pathogenic Effect and the Nature of a Toxin produced by Bacillus Paratyphosus B."

The seventh Edison medal, which was awarded to Nikola Tesla "for meritorious achievements in his early original work in polyphase and high-frequency electric currents," will be presented to him at the annual meeting of the American Institute of Electrical Engineers in the auditorium of the Engineering Societies Building, New York, on the evening of May 18. President H. W. Buck will preside, and addresses will be made by Dr. A.

E. Kennelly, chairman of the Edison medal committee; Charles A. Terry, New York, and B. A. Behrend, Boston.

Professor Hiram Bingham, of Yale University, and Dr. Isaiah Bowman, of the American Geographical Society, have been elected corresponding members of the Geographical Society of Philadelphia.

Professor Robert A. Millikan, of the department of physics of the University of Chicago, has been appointed to direct research by the National Research Council. He has been granted leave of absence by the university for the spring quarter.

Dr. Beverly T. Galloway, formerly assistant secretary of agriculture, will work in cooperation with the Council for National Defense in mobilizing the agricultural interests of the country.

President Trotter, of West Virginia University, has appointed the following committee to cooperate with the National Research Council: Professors Waggoner, Reese, Davis, Alderman and Schultz.

Dr. Alexander Hamilton Rice has returned to New York on the steam yatch *Alberta*, on which he sailed in November last to the upper Amazon River. The party included William T. Councilman, professor of pathology in Harvard University; Ernest Howe, a geologist, of Newport, and Earl F. Church, of the United States Coast and Geodetic Survey.

Professor Julius Stieglitz, director of the chemical laboratory, University of Chicago, and president of the American Chemical Society, gave, on April 20 and 21, two lectures before the department of chemistry of the Johns Hopkins University on the electronic conception of valence. Dr. Eugene C. Bingham, professor of chemistry at Lafayette College, recently gave three lectures before the department on the nature of viscous and plastic flow.

Henry Martyn Seely, professor emeritus of chemistry and natural history at Middlebury College, died on May 4, in his eighty-ninth year. He was active head of his department for thirty-four years. Professor Seely, who is a graduate of Yale College, a member of the American Geological Society and a fellow of the American Association for the Advancement of Science, was the author of important publications on the origin of the Champlain Valley.

Dr. Henry McHatton, a distinguished physician and surgeon of Macon, Ga., died on April 2, at the age of sixty-one years. Dr. McHatton had been president of the Medical Association of Georgia and medical director of the Macon Hospital. He was the author of numerous contributions to medical science.

Surgeon-General Sir William Taylor, late director-general of the Army Medical Service of Great Britain, died on April 10, at Windsor.

The *Journal* of the American Medical Association reports deaths as follows: I. A. Shabad, professor of pediatrics at the state Woman's Medical College at Petrograd, aged forty-seven years, who had made a special study of rachitis, its origin, nature and treatment. A. Prieur, editor of the *France médicale*, which he transformed into a historical journal, founder of the Société française d'histoire de la médecine, aged fifty-two years. W. Winternitz, the pioneer of scientific hydrotherapy, professor of internal medicine at the University of Vienna since 1881, aged eighty-two years. C. Hartwich, professor of pharmaceutical chemistry, at Zurich, aged sixty-five years.

Professor Bradley M. Davis, secretary of the American Society of Naturalists, reports the following actions of the executive committee:

First. The publication of the number of the *Records* due in 1917 has been deferred, the executive committee holding the view that the funds of the society should not be employed at this time on a publication which is not vital to its welfare.

Second. It has been voted that the next meeting of the Naturalists be held at Pittsburgh in conjunction with the meetings of the American Association for the Advancement of Science.

The ninth semi-annual meeting of the American Institute of Chemical Engineers will be held in Buffalo, N. Y., from June 20 to 23.

On May 5 administrative officials of 180 leading institutions of learning in the United States conferred with a committee of the Advisory National Defense Commission and arranged machinery for cooperation with the government during the war. Secretary Baker told the conference that important defense work could be done by the schools of the country, and the educators adopted resolutions embodying plans for active service. The resolutions recommended that the Bureau of Education and the States' Relations Service prepare a comprehensive policy of cooperation between the government and the educational institutions "which will make for the most effective use of these institutions throughout the duration of the war." In a statement of principles adopted the educators went on record as believing that all colleges and universities should so modify their calendars and curricula as to comply fully with the present needs of the nation.

At the annual meeting of the China Medical Missionary Association of Yale University, in January, Dr. Edward H. Hume presented a comprehensive report upon the status of medical education throughout the country, basing his conclusions upon his recent inspection of all the medical centers from Moukden to Canton.

The Minnesota legislature, recently adjourned, passed a law giving the Minnesota State entomologist needed authority to combat the white pine blister rust in that state, and appropriated for his use $15,000 for the biennium for fighting this disease. The U. S. Government will also use in the state an equal sum. It is hoped, with the legal machinery and the money available, the disease can be stamped out where it occurs in a limited area on the eastern boundary of the state.

A number of Akron rubber factories have established at the Municipal University of Akron thirty scholarships in the engineering college to be chosen from high-school graduates ranking in the upper third of the class, preference being given to graduates of Akron High Schools although others will also be received. The scholarships will cover all tuition, incidental and laboratory fees. Upon entrance the scholarship holders will be assigned to a course upon the cooperative basis, working alternate two week periods in factory and college. Each student will receive from the company employing him the sum of $37.50 for each two-week period during which he is employed. At the end of the four-year course the graduate will have the opportunity of a permanent position in the organization in which he has been trained.

A course on laboratory organization and management is offered in connection with the summer session at Columbia University by Professor Thomas B. Freas and Professor W. L. Estabrooke. The course is planned to take the students' full time for six weeks. The subjects carried will be: location, laboratory construction, ventilation, etc., of buildings; laboratory equipment, including desks, lockers, shops, gas, electricity, water, suction, liquid and compressed air, balances, etc.; buying from foreign and domestic markets, economic and scientific handling of supplies; organization of stockroom employees and their cooperation with the teaching staff; glass blowing by a professional glass blower will be a special feature; a series of trips in and about New York to manufacturing establishments, industrial and university laboratories, including trips to Boston, Washington, Niagara Falls, Buffalo, Rochester, Syracuse and Philadelphia, in which there will be opportunity to observe application of chemistry especially to university, college and research laboratories.

It is announced that an Italian who had long made his home at Marseilles has bequeathed $7,000,000 to the city of Marseilles, mainly for the purpose of founding and maintaining a large hospital.

The Medical and Chirurgical Faculty of Maryland has created a fund of $10,000, to be known as the Osler Testimonial Fund, the income of which is to be used for the purchase of books for the faculty, library and for the

upkeep of the hall which bears Sir William Osler's name.

On April 30 an illustrated lecture on "The Talgai Skull; a Fossil Human Skull Found in Queensland, Australia," was given before the American Ethnological Society, at the American Museum of Natural History by Professor S. A. Smith, professor of anatomy in the University of Sydney. A cast of the skull was exhibited. In view of the fact that this skull is the first relic of Pleistocene man to be discovered in Australia, and one of the most primitive human skulls known, especially as regards the palate form and dentition, this find ranks as one of the most important in human prehistory. Dr. Smith's very careful studies of the Talgai skull will shortly be published by the Royal Society of London.

We learn from *Nature* that recent enterprises in connection with the preparation of food and the development of its concessions in West Africa and elsewhere have led to the establishment of a research department by the Cooperative Wholesale Society, and Dr. Geoffrey Martin has just been appointed to direct its work. This appointment marks a new departure in connection with the cooperative movement, and has been rendered necessary by the concessions acquired by the Cooperative Wholesale Society in West Africa, Nigeria and elsewhere, as well as by the development of fresh undertakings at home.

The resident commissioner of the Bechuanaland Protectorate has written respecting the preservation of the remains of Dr. Livingstone's house at Koloben, and of the graves in its vicinity. It appears that action in this direction was the outcome of an appeal by Sir Meiring Beck that steps should be taken to preserve these mementoes of Livingstone's early missionary labors, dating from his residence among the Bechuanas before starting on his great exploring journeys to the north. Through the cooperation of the chief Sechele the ruins have now been fenced in and a shed has been erected over the remains of the walls of the house. The ground will in future be regarded as under government protection, and Sechele has been impressed with the necessity of keeping the site clear of jungle and guarding against injury by veldt fires or cattle. The headman of a neighboring village has been placed in charge, and an inspection of the site will be made from time to time.

Knowledge, the English magazine devoted to popular science founded by the late Mr. Richard A. Proctor thirty-six years ago, which has hitherto appeared monthly, will be published four times a year during the war.

It is announced that beginning on May 15, *Psychobiology* will appear every second month and will include in the yearly volume, approximately 600 pages. Its pages will be devoted primarily to research which lies in the field common to psychology and the several biological sciences, or which has a distinct bearing on the biological foundations of psychology. No formal limit of length has been imposed on contributors, but short articles will be preferred, and unnecessary length will be considered a bar to publication. While the function of the journal will be primarily to promote the speedy publication of research, discussions of important points may be admitted at the discretion of the editors, such discussions being limited in any case to two pages. Manuscript submitted for publication should be addressed to Professor Knight Dunlap, The Johns Hopkins University, Homewood, Baltimore, Md.

The New York Botanical Garden announces its course of spring lectures for 1917. The lectures will be delivered in the lecture hall of the Museum Building of the Garden, Bronx Park, Saturday afternoons, at four o'clock, as follows:

April 28. "Early Spring Flowers," by Dr. N. L. Britton.

May 5. "School and Home Gardening Courses at the New York Botanical Garden," by Mr. Henry G. Parsons.

May 12. "The Spring Flower Garden," by Mr. G. V. Nash.

(Exhibition of Spring Flowers, May 12 and 13.)

May 19. "Garden Soils and their Treatment," by Professor H. F. Button.

May 26. "Modern Methods of producing Seeds for Farm and Garden," by Dr. A. B. Stout.

June 2. "Vacant-lot Gardening," by Mr. Carl Bannwart.

June 9. "Garden Roses," by Professor A. C. Beal.

(Exhibition of Roses and Peonies, June 9 and 10.)

June 16. "The Seaweeds of New York and Vicinity," by Dr. M. A. Howe.

June 23. "Lillies for Everybody," by Mr. Arthur Herrington.

June 30. "The Food Value of Wild Mushrooms," by Dr. W. A. Murrill.

WE learn from the *Fisheries Service Bulletin* that in the early part of September the *Fish Hawk* made another cruise in Chesapeake Bay for the purpose of ascertaining the abundance and quality of the hydroid, or "sea moss," material available at this season. A Baltimore manufacturer of sea-moss articles accompanied the vessel. While the growth is not of the best quality at this season, abundant supplies were obtained, and the manufacturer expressed himself as well satisfied with the opportunity for a commercial fishery. On the conclusion of this trip the eighth regular cruise of the Chesapeake Bay investigation was completed. During the latter part of August the schooner *Grampus* left Norfolk, Va., to continue investigations in Atlantic coast waters, in charge of W. W. Welsh. A line of hydrographic stations was first made from Cape Henry to the gulf stream. About twenty miles southeast by east from Cape Henry a good haul of croakers was made with a small otter trawl, suggesting the possible use of this type of net for the capture of this species. Samples of sargassum weed were obtained for analysis in regard to the possible use of this material as a source of potash, and possibly of iodine and bromine. The vessel then proceeded to Cape May, N. J., and an examination was made of the pound nets in the vicinity of Five Fathom Bank. Observations were continued between Cape May and Gloucester, Mass. At the latter point a shortage of seamen made it necessary to tie up the vessel, and the work that had been planned for the Gulf of Maine was, therefore, abandoned.

UNIVERSITY AND EDUCATIONAL NEWS

PLANS are now being prepared for a new chemistry building at the Montana State College to replace the one burned down last October.

FIVE departments of fellowships in mining and metallurgical research, each valued at $720 for a year of twelve months, are offered by the College of Mines of the University of Washington in cooperation with the federal Bureau of Mines.

DR. EDWARD M. FREEMAN, assistant dean of the department of agriculture of the University of Minnesota, has been offered the deanship of the college of agriculture of the University of Arizona, at Tucson.

THE following instructors at Wellesley College have been advanced to assistant professorships: Mabel A. Stone, botany; Helen S. French, chemistry, and Sarah R. Davis, hygiene.

DR. HOWARD PARSHLEY, who has been working at the Bussey Institution, Harvard University, has been appointed assistant professor of zoology at Smith College.

FRED T. ROGERS, Ph.D., assistant professor of physiology in Baylor University, Waco, Texas, has been appointed to an instructorship in physiology at the University of Chicago.

J. F. REILLY has been promoted to an associate professorship of mathematics at the State University of Iowa.

VICTOR E. RECTOR, principal of the Antioch Industrial School near Hartsville, S. C., and a member of the House of Representatives, has been elected professor of agriculture at the University of South Carolina.

DISCUSSION AND CORRESPONDENCE

THE VARIETAL RELATIONS OF CROWN GALL

THE disease known as crown gall and hairy root has been the subject of much experimental inquiry. It has long been known that there were several forms of this disease appearing on apple trees and for some time it was a question whether these several forms were due to the same causal organism. There have been recognized a hard and a soft form of crown gall and the simple, woolly knot, broom root and aerial forms of hairy root.[1]

[1] Hedgecock, Bureau of Plant Industry, Bulletin 186.

The writer has during the past few years propagated several thousand apple trees of many different varieties on their own roots by means of the common whip graft, but cutting off the seedling nurse root after two seasons' growth and replanting those trees which had thrown out roots from the scion, thus establishing the variety on its own roots. Many of these trees have been more or less troubled with the crown gall and hairy root. It has been observed that there is a tendency for a given variety to have only a single form of the disease. Thus the Jewett apple shows usually if not always the hard form of the gall, the Red Astrachan the simple form of the hairy root and the Oldenburg the woolly knot form with many soft fleshy root growths. Other varieties show the broom root form and still others often the aerial form.

In the ordinary method of propagation of apple trees the root systems are of seedling origin and from a pomological viewpoint the root system of every tree is a different variety. May not this be the reason for the various forms of crown gall and hairy root?

Some varieties on their own roots seem to be largely if not entirely immune to this disease. If this proves to be really the case, here may lie the solution of the problem of the prevention of crown gall. If a resistant variety is selected as the root variety, and the variety desired propagated on it, trees immune to the disease may presumably be secured. Probably the economic advantage would warrant the extra effort necessary to propagate such trees, only under conditions where the crown gall was especially troublesome.

There are other root diseases which are injurious, especially through the southern part of the apple belt, that might possibly be avoided in a similar fashion.

J. K. Shaw

Massachusetts Experiment Station

WHEN A FORCE IS A FORCE

Referring to the perennial discussion of the meaning of force and of the law of action and reaction, lately revived in the pages of Science,[1] I venture to suggest that the essential point of the alleged difficulties which have been raised is covered by the following simple propositions:

1. A force is a *push* or a *pull* exerted upon a body (portion of matter) by another body.

2. Whenever a body A pushes or pulls a body B, then at the same time B pushes or pulls A equally in the opposite direction. Such a pair of forces is an "action and reaction." *An action-reaction pair concerns two bodies and only two.*

3. The two forces of an action-reaction pair never balance each other; a force acting on A can not balance a force acting on B.

4. To balance a force acting on B, another force must be applied to B.

One who keeps these simple facts in mind will, I believe, find it easy to decide whether an alleged force is really a force in the meaning of the Newtonian laws. He will also see that there is no contradiction between the statement that forces always occur in action-reaction pairs and the statement that forces are often unbalanced.

L. M. Hoskins

Stanford University,
March 22, 1917

[1] See articles by Gordon S. Fulcher (November 24, 1916), and Andrew H. Patterson (March 16, 1917). Mr. Fulcher's discussion seems to me to be entirely sound.

SCIENTIFIC BOOKS

The Potato. By Arthur W. Gilbert, assisted by Mortier F. Barrus and Daniel Dean. New York, The Macmillan Co., 1917. Pp. i–xii and 1–318, Pl. XVI.

The author states in his preface that the book is intended to give brief and practical suggestions on the growing, breeding and marketing of potatoes, and the subject-matter amply substantiates the statement. This publication, in addition to being up-to-date in its cultural directions, devotes considerably more attention to the subject of potato breeding than any of our preceding American treatises on the potato. Conveniently arranged statistical data are presented in Chapter I. under the caption of Acreage, Distribution, Production and Valuation. Chapter III. em-

bodies the various classification systems which have been advocated by American writers, and, in addition, presents a very conveniently arranged list of varietal names and so far as identified places them in the various classification systems under their group names. This should prove of no little convenience to those interested in the subject.

The three chapters devoted to "Climate, Soils and Rotations," "Manures and Fertilizers," and "Planting," are excellently treated, the suggestions being clear, concise and practical. In the opinion of the writer, the value of the subject-matter in these chapters would have been enhanced by a few well-selected illustrations of potato implements and cultural methods. The discussion of potato diseases and their control is clear and convincing and should prove very helpful to both the farmer and the student. A chapter on "Markets, Marketing and Storage" is both suggestive and helpful, as is also that on the cost of growing potatoes.

As a whole, the book is unique, in that it is strikingly devoid of illustrations, as compared with most of the recently published agricultural text-books. It is a welcome addition to our present text-books on the potato, and should find a place in the classroom of agricultural schools and colleges.

WM. STUART

Health and Disease: Their Determining Factors. By ROGER L. LEE. Little Brown, Co., 1917. $1.75.

This book gives a very pleasing presentation of the factors of health and disease in strictly non-technical language. The author has successfully and very commendably avoided a consideration of the treatment of ailments, and has emphasized throughout the preventive measures which may be performed, or encouraged by the cooperation of the layman. The most reprehensible thing in the book, from the reviewer's view-point, is the title of Chapter XII., "The Air-borne Diseases!" After the struggle that has been, and is being made to disillusion the popular mind of the idea that air is an important conveyor of disease, it is a misfortune to use this phrase in any sense. The author goes to some pains to explain that he includes under this term chiefly "droplet" or mouth-spray infection, but the use of "air-borne" throughout the book is bound to nourish the age-old fallacy.

The first nine chapters consider chiefly matters of personal hygiene, the next nine, communicable diseases, and the last six, matters of general sanitation. The sequence and point-of-view throughout are good. Specially to be commended are the chapters on Alcohol, Tobacco and the Habit-forming Drugs and on the Venereal Diseases and Sex Hygiene.

There are a good many minor criticisms which might be made, as, for example, the loose use of the term antitoxin on page 173, speaking of the "*Spirochæta pallida*" instead of *Treponema pallida*, the sentence "'Red flap' is caused by a ringworm which is really a vegetable bacterium" (p. 243), and the statement that "tubercle bacilli are only present in milk when there is tuberculous disease of the udder" (p. 306).

The book contains 378 pages, is printed on rough paper in good print and is amply indexed. There are no cuts or diagrams in the book and no specific references are given. It is to be most cordially recommended to the lay reader and might find a useful place as a text in a general elementary college course in hygiene and sanitation, and should certainly be on the desk of every teacher of biology and hygiene.

CURTIS M. HILLIARD

SIMMONS COLLEGE

SPECIAL ARTICLES

A NOTE ON THE EFFECT OF ASPHYXIA AND AFFERENT STIMULATION ON ADRENAL SECRETION

RECENT observers have expressed some doubt as to the effect of asphyxia and afferent stimulation on the secretion of the adrenal glands. Under the circumstances it is desirable to have simple methods which any one may use to demonstrate the effect. During the past few months, with the aid of Mr. H. F. Pierce, I have devised such methods.

If both carotid arteries, both subclavian arteries and the aorta just anterior to the inferior mesenteric artery are tied, and the

nerves accompanying the cœliac axis and the superior and inferior mesenteric arteries are then carefully severed, a rise of blood pressure taken from the carotid must be mainly due to contraction of the splanchnic area which is now denervated. If a vigorous cat is operated upon in this way under light urethane anesthesia, asphyxia for one minute will result usually in a rise of blood pressure at the end of forty seconds and a very considerably greater rise as soon as respiration begins again. These results do not occur if the adrenal glands are removed. If these glands are left in the body, but disconnected from the central nervous system, a rise of pressure may still be produced if the asphyxia is continued for a considerably longer period than is required when the splanchnic nerves are intact.

If the heart is completely denervated by severing both vagi in the neck and removing both stellate ganglia, it becomes a very delicate indicator of increased adrenin in the blood. Stimulation of the central end of the cut sciatic nerve (in a cat under urethane) will then cause the heart rate to increase, in some instances 50 beats a minute. The phenomenon does not occur if the adrenal glands are removed or if the splanchnic nerves are cut. The method is advantageous in that it shows the latent period and the duration of the secretion. The effect on the heart of asphyxia is not so great as the effect of afferent stimulation, in all probability because of the antagonism between the influence of carbon dioxide and of adrenin.

A great deal of care must be taken in operating on the abdominal cavity to avoid manipulation. As was shown many years ago, such operations produce changes which can be best accounted for by continuous discharge of the nerve impulses along splanchnic courses. Thus the adrenal glands would be persistently stimulated. A potent source of error in previous work, in which the abdominal cavity has been opened, has doubtless been the failure to exercise extreme care to avoid rough manipulation.

A full account of this investigation will be published in the *American Journal of Physiology*.

W. B. Cannon

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 567th regular meeting of the society was held in the assembly hall of the Cosmos Club, Saturday, March 10, 1917, called to order by President Hay at 8 P.M., with 45 persons in attendance.

On recommendation of the council Mrs. L. O. Howard and Dr. Martha Brewer Lyon were elected to active membership.

Under the heading book notices, brief notes, etc., Dr. H. M. Smith exhibited a manuscript and hand-illustrated book dealing with beetles. It was about 60 years old. Dr. Smith presented it to Dr. L. O. Howard. Professor W. P. Hay presented some notes on the flying squirrels of this vicinity with observations on their habits and behavior as pets. Dr. H. E. Ames called attention to a newspaper clipping recording the flight of two tagged ducks a distance of 2,000 miles in about 60 hours. He sought verification of the statement.

The regular program consisted of two communications:

Precipitins: M. W. Lyon, Jr.

Dr. Lyon described an anti-beef serum he had lately prepared, and set up a series of test tubes containing dilutions of beef, sheep, hog and human serums, and demonstrated the action of the anti-beef serum on these, viz., specific precipitation when added to the diluted beef serum, group precipitation with diluted sheep serum, and the non-precipitation with diluted hog and human serums. He mentioned briefly the history and theory of precipitating serums and explained their use in identifying suspected animal proteins and in showing the blood relations of various animals. In discussing this communication A. H. Jennings explained how he had made use of the precipitin reaction in determining the kinds of animals bitten by biting flies. Dr. George W. Field and H. F. Taylor also took part in the discussion.

Porpoises and Steamers: William Palmer.

Mr. Palmer commented on the frequency with which porpoises are found about the bows of steamers and advanced explanations as to their presence there and methods of progression. His communication was illustrated by diagrams and lantern views of porpoises and other cetaceans. It was discussed by Dr. H. E. Ames.

M. W. Lyon, Jr.,
Recording Secretary

SCIENCE

FRIDAY, MAY 18, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PROVISION MADE BY MATHEMATICS FOR THE NEEDS OF SCIENCE[1]

MATHEMATICS beyond the merest elements has been regarded by some as an excrescent malady of the human spirit, generated like the pearl in an abnormal and morbid way and representing a non-living embedment in the active tissue of the organism of society; by others it has been supposed to exhibit the highest intellectual reach of mankind, being in itself the most powerful tool yet devised for the interpretation of natural phenomena, while at the same time it affords a satisfying expression of the furthermost esthetic attainment. On the one hand, it is considered a piece of jugglery in which it is the joy of the proficient to produce more and more complicated entanglements to astonish the beholder and overwhelm him with the sense of mystery; on the other hand, it is seen to be the systematic unfolding of remarkable and important properties of a highly fascinating creation or construction of the human spirit by means of which it has at once its most intellectual delight and the best means of understanding its environment. Some workers seem to resent the interference of mathematics with their comfort in the conclusions of descriptive science and its demands that observation shall be reduced to measurable elements and the laws of nature be expressed in mathematical formulas; other thinkers believe that natural science is real science only in so far as it is mathematical, that it is only through mathematics that true science can

[1] An address delivered before the Illinois Chapter of Sigma Xi on January 17, 1917.

be understood, and that without mathematics no science can develop to maturity. One delights in observation and the record of facts, believing that he has understood a class of phenomena when he has given a general description of their relations, order and connections; the other considers the mathematical formula as "the point through which all the light gained by science must pass in order to be of use in practise."

But it is true, I believe, that mathematics is generally recognized as essential at least to scientific progress; and what I intend to do this evening is to discuss the nature of the provision made by it for the needs of science. But I can not consent to enter upon a treatment of this topic without pausing a moment, first of all, to combat a certain dangerous and apparently rather widespread error among scientists, namely, that the primary and perhaps the sole function of mathematics is to assist in the solution of the problems of science. If this were the essential purpose of mathematics, you would not find it cultivated as it is to-day. Instead of this the men who now give all their energy to its development would be allied with the particular natural sciences and would study mathematics only as auxiliary to their central concern. One could find no incentive to labor otherwise.

Fundamentally mathematics is a free science. The range of its possible topics appears to be unlimited; and the choice from these of those actually to be studied depends solely on considerations of interest and beauty. It is true that interest has often been, and is to-day as much as ever, prompted in a large measure by the problems actually arising in natural science, and to the latter mathematics owes a debt only to be paid by essential contributions to the interpretation of phenomena. But after all, the fundamental motive to its activity is in itself and must remain there if its progress is to continue.

Some mathematicians are glad when their fields of thought touch other sciences (or even practical matters); others concede the fact unwillingly or without interest; others still would perhaps consider themselves unorthodox in their feeling if they allowed any matter of connections with other things to affect at all their interest in their own fields. It was perhaps an extreme case of this feeling which prompted Sylvester to the pious or impetuous hope that no use would ever be found for the theory of invariants which he was developing with so much delight.

But it has turned out, as the mathematician is now well aware, that it is these same invariants which afford us an expression for the laws of nature. An invariant is simply a thing or a relation which remains unaltered when the elements with which it is connected undergo a certain class or group of transformations. When we know the transformations to which a class of phenomena are subject the matter of finding out the laws connecting these phenomena is a problem of invariants. It may be that a particular physical law was discovered long before the idea of invariants arose; but it is nevertheless true that a useful connection among such laws is afforded by this notion. On the other hand, we may have an equation expressing a fundamental relation among a large class of phenomena and find that this equation is invariant when the elements in it are subjected to a certain group of transformations. We may be sure that this group of transformations has something essential to do with the phenomena in consideration, and that its invariants express (partially or completely) the laws governing these phenomena. Our problem

is then to deduce these invariants and to give to them a physical interpretation.

In the theory of invariants we have an illustration of a fundamental fact concerning the applications of any but the most elementary mathematics, namely, that they arise essentially as by-products of the leading discoveries. On the part of those who make use of them they are often considered as the essential and perhaps the only results of mathematical investigation. There are some who have been impatient of those studies which apparently have no connection with less abstract considerations. But this is a short-sighted impatience. He who wishes applications and applications alone can not secure his ends better than by the encouragement of theoretical investigations even of an abstruse and remote character. Within the separate natural sciences this is so well understood that it is a matter of surprise to observe that some individuals persistently refuse to carry the conception to its logical consequence as regards the science of mathematics. But any one who has meditated much on the character of the progress of thought must certainly have a profound realization of its truth.

It seems that no body of thought has been of more importance in human progress and at the same time been criticized more freely than the science of mathematics. Much of this criticism appears to be good-natured and to amount to but little more than a quasi-humorous way of expressing the critic's own unashamed ignorance. At first sight one might treat this as harmless; but from the point of view of the general interest it can hardly be passed over in such a way. How this ignorance is to be overcome I can not say. Perhaps one of the first requisites is to find some means of overcoming the shamelessness with which individuals otherwise well trained contemplate their own ignorance of mathematics.

The mathematician himself is not disturbed so far as the welfare of his own science is concerned; but it is sometimes a matter of pain to see the general loss which arises from such ignorance and also from the severer strictures of the more pronounced adversaries of mathematics. In no other case, however, have the criticisms been so severe as those meted out to the infinitesimal calculus in the infancy of its development; and never have the fondest hopes of the founders of a science been so far surpassed by its actual achievements as here where the subject has become central in practically every field of pure and applied mathematics.

It will be instructive to examine briefly the criticisms thus met so early by the infinitesimal calculus. Some persons attacked the certainty of its principles, attempting to show that its conclusions were at variance with those obtained by methods previously known and accepted as sound. Some who labored primarily with matters of morality and religion attacked the new departure of thought on general grounds; they repulsed themselves by unwittingly displaying their ignorance of the thing which they criticized. One man, who entrenched himself in masses of calculation, pronounced the procedure of the new calculus unsatisfactory because of the indeterminacy of the form in which certain results appeared; but he afterwards acknowledged his error and admitted that he had been urged forward by malevolent persons—a thing (let us believe) which does not often happen among workers in science. Christiaan Huygens, whose opinion probably carried more weight than that of any other scientific man in his day, believed that the employment of differentials was unnecessary and declared that Leib-

nitz's second differential was meaningless. But these and many other criticisms never hindered the development of the new calculus, but served rather to aid in clearing off certain excrescences which had nothing to do with its essential characteristics and in helping it to that central place of importance which it holds to-day.

The criticism last mentioned is one which is made so often that it is profitable to dwell longer upon it. So often the mathematician hears: "What is the use of what you are doing?" He knows a thousand answers to this question; and one of the most effective is that which history has given to the criticism of the illustrious Huygens. The recently developed subject of integral equations has sometimes been confronted with the inquiry: Why develop this theory? Will not differential equations serve the purpose? But the mathematician goes calmly ahead with the development of those things which interest him just as he did formerly; and in the new case he anticipates with confidence the same triumphant justification in the event which has uniformly crowned his labors in the past.

Sometimes the criticisms directed against mathematics have grown out of a misconception of the natural limitations to which it is subject. Pages of formulas can not get a safe result from loose data. No amount of computation will remove from a result the errors already existent in the underlying observations. I have several times been confronted with the statement that mathematics made a great mistake in this or that particular case in predicting what was not found on proper examination to be true. But after all there was nothing wrong with the mathematics. It was merely that the supposed laws of phenomena on which the investigation was based were not exact. It was they and not the mathematics which were on trial.

It is true, as one of my friends said to me recently, that no machine can be constructed and completely theorized on mathematical principles alone. When this is given as a statement of fact I have nothing to say in reply. But if this natural limitation of the subject is spoken of (as I have sometimes heard) as an expression of the failure of mathematics, then an error is made which ought to be corrected. Mathematics does not claim to do the whole thing in the development of science. It simply has its rôle to perform; and there is a devoted body of workers throughout the world striving to see that it perform this function with eminent success. How it does and is to continue doing this will be apparent from the following discussion of the relation of mathematics to experimental verification.

By their very nature the conclusions of pure mathematics are not subject to experimental examination. One would not say that they are above or beyond experience, but that they are outside of it. Pure mathematics deals with certain creations of the human spirit and with these alone. So far as it is concerned, no import attaches to the inquiry after the impulse which resulted in the creation of these things. The mathematician *qua* mathematician is not interested in this matter, however much it may fascinate him as a philosopher; and he develops his science usually with perfect indifference to such considerations, rearing it from a small group of postulates or perhaps even from the general logical premises of all reasoning. In any event, he drags out into the limelight all hypotheses and keeps them vividly before him during the progress of his investigations.

In applied mathematics the state of things is very different. Here the whole treatment is bristling with implicit assumptions, some of them being carried con-

sciously while many of them are apparently unperceived. In other words, while we are applying mathematics we are at the same time making use of the customary large bundle of prejudices and preconceptions which we have not yet found a way to avoid whenever we have to treat the phenomena of nature.

In order to illustrate the way in which applied mathematics is shot through with assumptions, let us take a single case. When we begin to apply numbers in the measurement of physical quantities we assume at once that the true measure may as well be an irrational number as a rational number. For this assumption we have no *a priori* grounds or experimental reasons. We simply find it the most convenient assumption to make and we make it, having no other justification than convenience for our procedure. It may very well be true that the universe is so constructed that every measurement in it yields essentially a rational number. This would be true if all material things, all force, all energy, etc., were granular in structure and the mutual ratios of all granules were commensurable. For instance, if it should turn out that mass is to be estimated by counting the number of granules (all alike) in a body, then the mass of the body would be expressed essentially by a rational number. If electricity consists altogether of electrons of equal charge, then the measure of any charge of electricity is essentially a rational quantity. But we treat the phenomena mathematically as if essentially irrational quantities occur generally in nature. Even the continuity of space apparently rests upon just such sheer assumptions.

Starting with this fundamental hypothesis of applied mathematics, we might follow the subject from these remotely abstract regions into the things of more common thought, and in doing so we should find that such fundamental assumptions obtrude themselves at every point. If we looked persistently only at this side of the matter we should probably lose all confidence in our theoretical interpretations; but fortunately we are able always to test our results approximately with experimental data. It is not that we are testing out our processes of reasoning (we have another method for doing that); but rather that we are examining as to whether we have found a construction and interpretation which fit in with phenomena to a satisfying degree.

After these remarks I will hardly need to urge the necessity of testing in the laboratory all results obtained from given hypotheses by logical processes. For we can never know the truth of any hypothesis, or even understand its import, until we know the consequences which flow from it. Whether the conclusions reached in this be determined only by an appeal directed to experience.

Among the fields of applied mathematics that of rational mechanics has been most completely transfused by the mathematical spirit and it is here that the latter has exhibited some of its most characteristic conquests. It has here shown how high mathematical skill on the part of some investigators is necessary to the greatest progress of science, illustrating the way in which the mathematical spirit and method furnish a bond of union to the separate divisions of physical science.

So far we have considered the character of the provisions made by mathematics for the needs of science. It remains to give some specific details as to the past and some indication of apparently probable lines of development in the future. Clearly, a catalogue of specific provisions would be impossible in this address; such a thing

would require not less than a year's course of lectures. We can not hope to do more than indicate some of the central provisions.

Let us begin with a consideration of the early stages in the development of particular sciences. Each separate experimental science passes through a period of infancy in which it is not able to stand the strong meat of mathematics; and mathematical ideas initially find an application in it by slow processes. The first essential is to gather data—descriptive results, measured quantities, or what not; and only after much labor does law become apparent and the mathematical tool acquire its characteristic power.

But even in these preliminary stages mathematics makes an essential contribution in a preliminary way. It furnishes the only language in which exact information can be expressed, recorded and conveyed; and in this respect is a necessary element of that collaboration which is essential to such rapid progress as has been usual in recent years. But it does more than this. It enables us to record observations in such a way that we are able readily to grasp the relations of the various measured elements involved. I refer here particularly to the use of graphs which present data in so compact a manner and in a way so well adapted to our intuitive realization of their significance.

It would now probably be impossible to lay the foundations of any new experimental science without the collection of much numerical data, that is to say, without the use of statistics. But how are these to be interpreted? Clearly it must be by the methods of statistical mathematics.

Let us suppose now that we have made a record of our measurements of phenomena, their juxtapositions, their magnitudes, their order in time; let us assume (as we always do and must) that they are connected by law. How shall we ascertain what that law is? By what criterion shall we judge of the accuracy of our hypothetical explanation? Certainly not on any absolute grounds; we can only select the explanation which seems to us most probable. And for this our best and surest guide is and must be the mathematical theory of probability.

A science in the stage now being examined would properly be called non-mathematical, notwithstanding the preliminary use which it makes of mathematical science. Among those divisions of systematic thought which are at present in this stage of development one would probably include political science, economics, biology, psychology and geology.

At the next stage of development one would think of the individual science as having come to the period of vigorous youth but not yet mature. As preeminently the example of such a science I would select chemistry. By no means is it reduced essentially to mathematical form; and yet its laws are so stated as to be subject to the sharpest experimental verification. It employs the mathematical tools which are common in the earlier stages of science and also some additional ones. It may even employ the first derivative as a measure of rate of the reactions which it considers; but I believe that it seldom or never makes use of the second derivative.

It may be taken as a mark of the more advanced development of physics that it finds constant use for derivatives of the second order and sometimes for those of higher orders. Some one has expressed this increasing order of complexity and certain accompanying dependencies by saying that behind the artisan is the chemist, behind the chemist is the physicist, and behind the physicist is the mathematician—a pleasing climax, at least if you are a mathematician.

When we look upon physics, for instance,

as a mature science, we are not to think of it as having become dead and unproductive. Like the individual scientific worker on coming to maturity, it has merely reached the period when its deeds become most effective for the use and satisfaction of mankind. In fact, physics is perhaps at the same time the most mature natural science at present existing and the one whose recent progress has been the most rapid and the most remarkable.

In the development of physics the infinitesimal calculus has persistently played a leading rôle; its interaction with experimental results has been and is fundamental and necessary to the progress we have witnessed and yet see to-day. From this creation of the mathematicians and the use made of it by the physicists the world has received a good practically immeasurable in its extent. Sometimes we are tempted to assess the advantages due to each of these elements; but one can hardly expect success from such a venture. Logically the mathematics is prior; for it could exist of itself, while the physics probably could not. But psychologically and practically they are so bound up that no separation can be made. Were the mathematics swept away, much of physical theory would likewise have to go; but on the other hand much of the mathematics would never have existed had it not been called into being by the demands of physical science.

Until recently it was customary to assume that nature is essentially continuous in her manifestations. As long as we proceed on that hypothesis the infinitesimal calculus is the natural tool to be employed in the investigation of phenomena; and we should expect to find differential equations and integral equations playing a leading rôle in the exposition of physical theory.

That they have done so has furnished a great incentive to some investigators in prosecuting their labors. It is said that Poincaré was urged on in his studies of differential equations by the conviction that he was engaged in perfecting the most important tool which could be employed in the investigation of physical phenomena. No doubt it is a similar use of integral equations which drew quickly into that field so large a body of workers and resulted in its so rapid development. The same spur has urged men on in the study of expansion problems in connection with both differential equations and integral equations. It is now a long while since Fourier series were thus introduced; and their properties and availability have been treated in numerous investigations.

More recently extensive generalizations of these series have made their appearance; and we have a great class of expansions in the so-called orthogonal and biorthogonal functions arising in the study of differential and integral equations. In the field of differential equations the most important class of these functions was first defined in a general and explicit manner by an American mathematician, Professor Birkhoff, of Harvard University; and their leading fundamental properties were developed by him. We shall doubtless witness a great progress in our knowledge of these functions.

But in the early years of the present century the world of scientific thought has been unexpectedly confronted with a new situation of a rather astonishing sort. Our unquestioning assumption of the continuity of nature appears now not to have been well founded; and much of the development of theory which has been based on it is consequently perhaps to be regarded as only a rough and unsatisfactory first approximation. If certain apparent discontinuities in nature turn out to be real (and it looks now as if they must) then the differential equation will probably lose its place as the most important tool of applied mathematics

and the corresponding expansions will no longer serve to yield us the most satisfying form for the expression of our results.

This situation has been contemplated with uneasiness in certain quarters. To some natural scientists it has seemed like the loss of our moorings. To some mathematicians it has appeared in the light of greatly lessening the importance of many investigations, difficult and prolonged. It is said that Poincaré contemplated the outlook with keen regret. But we had as well make up our minds to the situation. It seems almost certain that electricity is done up in pellets, to which we have given the name of electrons. That heat comes in quanta also seems probable. In fact, it is not unlikely that we are on the verge of interpreting everything in nature as essentially discontinuous; and it would perhaps be no surprise to us now to find that even energy itself is not unlimitedly divisible, but exists, so to speak, in granules which can not be separated into component parts.

A few years ago such a paragraph as the foregoing would have been thought a piece of nonsense and to be not entitled to consideration; now the author is more likely to be charged with repeating something which already has been heard to the point of weariness.

In view of so sweeping and fundamental changes in our outlook, what is going to happen to the existent body of applied mathematics? Simply this, if these new ideas gain currency: that which before had been considered a very close approximation to facts will now be treated as giving only a coarse first approximation; and we shall set about the task of finding means of studying phenomena more exactly in consonance with the new underlying ideas.

You will probably be disposed to ask in what direction we shall turn now to find the requisite mathematical tools and when we can expect to have them ready for use. It may be answered that the mathematician was beforehand with a partially developed tool which will probably serve the purpose. When these new ideas in physics were just coming to the front a few young mathematicians independently of each other and apparently without knowledge of these movements in physics were engaged in the study of certain mathematical problems having to do with a thing which will probably turn out to be a suitable tool for the investigation of discrete phenomena. At any rate, the equations which they were studying are not intimately bound up with considerations of continuity as are differential equations, but yet they possess a number of properties very similar to or in common with those of differential equations. The equations which are thus brought to a new position of importance are the so-called difference equations.

Simple difference equations first appeared in the literature rather early in the history of mathematics and certain elementary aspects of their theory were considered several generations ago. But in recent years an essentially new type of problem in connection with them has come to notice; and in a short time and through several independent investigators the theory has suddenly blossomed forth into unexpected and magnificent flower.

This development had its origin almost simultaneously in three countries and in the hands of three independent investigators: Nörlund in Sweden, Galbrun in France, and myself in America. My own first contribution was followed closely (also in this country) by Birkhoff's first fundamental paper in the new field. By this time numerous other persons have made contributions to the development of the subject both from the function-theoretic point of view of the papers just mentioned

and also from another direction with a consequent consideration of a different type of problem.

So far the recent workers in this field have given their entire attention to purely mathematical developments and have not considered so much as the possibility of a use of the results in the domain of applied mathematics. In particular, my own interests have been in theoretical considerations. But I look forward to important applications of this newly developed theory both because it seems to have in it some at least of those elements which are necessary to accord with phenomena which are discontinuous in their nature and more particularly because there is here an expansion theory also consonant with the discontinuities of nature and related to difference equations in a manner somewhat similar to that in which certain other expansion problems attach themselves to differential equations. But the analogy must not be pressed too far, since there are also essential differences.

Concerning these new expansion problems I wish to say one further word. It is very recently indeed that they have come to notice; and a knowledge of them is not yet generally current. In fact, the general definition of the series involved was first made in a paper of my own published less than a year ago; and I am still engaged in working out their more detailed theory. Doubtless other workers in the near future will take up different phases of the same problem.

So far no exposition of the modern theory of difference equations exists in the literature; the results are to be found only in the original memoirs. In a few instances this theory has furnished the basis or an integral part of a course of academic lectures. As such it has appeared, as I understand, in one of the courses at Harvard. I have myself delivered lectures on it in Indiana University and the University of Chicago; and it is my purpose next year to expound this new doctrine in my lectures here. It is highly desirable that this matter shall be developed rapidly and be prosecuted from various points of view. It is in this way only that we shall be able to learn what its import really will be for the progress of science.

Before concluding my remarks I wish to speak briefly of a different sort of conception or expectation which has arisen in some quarters and having to do with a more fundamental and far-reaching use of mathematics than any yet made. It is connected with the fact that every branch of physics gives rise to an application of mathematics and the consequent feeling that there must be a deep underlying reason for this and a consequent close relation of phenomena which probably makes them capable of an explanation from a single point of view consistently maintained.

If there is a "hypothetical substructure of the universe, uniform under all the diverse phenomena," it would appear that there must be some means of ascertaining what it is and of giving to it a mathematical expression and body. At any rate the expectation of such a thing has arisen; let us hope that the event will show that the anticipation is well grounded in the nature of things.

I understand that the earliest contributions to just such a development are already in existence; that the now current theoretical accounts of radiation, diffusion, capillary action and molecular behavior in general have just such characteristics as one would expect to find in the early stages of a mathematical theory of the substructure of the universe.

Let me guard against a misapprehension concerning the foregoing remarks. I have

not been discussing the general elements in scientific progress; my purpose has been much less ambitious. In speaking to my colleagues in other fields I have tried to give an account of the faith that is in me so that they shall see what sort of motives (aside from those of esthetic delight, which however are central) the mathematician has in the work which he pursues. With this purpose before me I have spoken of just one side of the fundamental requisites of scientific progress. And now I wish to say with emphasis that I have the keenest appreciation of the use and purport of other methods and the sharpest delight in the contemplation of their achievements——achievements so different from any to be wrought out by my own familiar and loved mathematical tools. One could hardly speak of these other methods without becoming eloquent in his admiration of them. They are left unmentioned, then, not because I do not appreciate them, but because they do not fall within the scope assigned to this discussion.

My purpose will have been served if I have tended to produce in your minds a keener appreciation of the place of mathematics in the development of scientific thought; and particularly if I have induced in you a conception and feeling of the consecration with which choice mathematical spirits devote their energies to penetrating into the unknown regions of their own creations and to opening up larger areas of the enormously expanding field of mathematics which has grown more in the present generation perhaps than in any other in the history of the world.

R. D. Carmichael

SCIENTIFIC EVENTS

THE GAUTHIOT MEMORIAL

Dr. Robert Gauthiot, directeur d'études adjoint in the Ecole des Hautes Etudes, one of the most brilliant Oriental scholars of our time, died in Paris on September 11, 1916, at the age of forty, from the effects of a wound received as captain of infantry while gallantly leading his company to a grand attack. Gauthiot was a real genius, and has made lasting contributions to Iranian and Indo-European philology, playing a prominent part in the recent movement of opening up the history of Central Asia. To his ingenuity and acumen is due the complete decipherment of the Sogdian, an Iranian language preserved in ancient manuscripts which some years ago were discovered in Turkestan. He conducted two highly successful expeditions into the Pamir for linguistic exploration. Hardly had he reached the Pamir for the second time in July, 1914, when news of the outbreak of the war determined him to return to France and to take his place in the defense of his country, distinguishing himself by his bravery and receiving the croix de guerre.

The loss caused to science by his premature and tragical death is irreparable. He has left in straitened circumstances a widow and four daughters, the youngest being three years of age. A committee has been organized for the purpose of raising a Gauthiot Memorial Fund in commemoration of the great scholar, this fund to be utilized for the maintenance of his destitute family and for the publication of a Gauthiot Memorial Volume. Any further information, if desired, will be gladly given by the secretary. Contributions which will be gratefully acknowledged may be sent to some member of the American committee, or if preferred, directly by draft on Paris to Professor A. Meillet (65 rue d'Alésia, Paris XIV^e, France), treasurer of the French Board of Trustees for the Gauthiot Memorial Fund.

The American committee consists of:

Martin A. Ryerson, 134 South La Salle Street, Chicago—*Honorary President.*

A. V. Williams Jackson, professor of Iranian and Sanskrit, Columbia University, New York.

James H. Breasted, professor of Egyptology and Oriental History, University of Chicago.

Walter E. Clark, professor of Sanskrit, University of Chicago.

B. Laufer, curator of anthropology, Field Museum, Chicago—*Secretary.*

AWARDS BY THE FRANKLIN INSTITUTE

THE Franklin Institute, acting through its Committee on Science and the Arts, has recently awarded medals to the authors of especially meritorious papers that appeared in the Institute's *Journal* during the year 1916. In making these awards, the committee adopted the following resolutions:

That the Howard N. Potts Medal be awarded to Professor Ulric Dahlgren for his paper entitled, "The Production of Light by Animals," appearing in various issues of the 1915 and 1916 *Journal* of The Franklin Institute, forming an original and comprehensive treatise of an extremely interesting and important subject.

That the Edward Longstreth Medal of Merit be awarded to Mr. George A. Rankin for his paper entitled "Portland Cement," appearing in the June, 1916, issue of the *Journal* of The Franklin Institute, a highly important contribution to the theory of cement chemistry.

That Edward Longstreth Medals of Merit be awarded to Professor A. E. Kennelly, Messrs. F. H. Achard and A. S. Dana, for their joint paper entitled "Experimental Researches on the Skin Effect in Steel Rails," appearing in the August, 1916, issue of the *Journal* of The Franklin Institute, containing new and valuable experimental data, heretofore unavailable to the designers of track return systems.

That the Edward Longstreth Medal of Merit be awarded to Mr. John D. Ball for his paper entitled, "Investigation of Magnetic Laws for Steel and Other Materials," appearing in the April, 1916, issue of the *Journal* of The Franklin Institute, containing new and valuable information relating to the magnetic properties of materials used in the magnetic circuits of electrical machinery.

That the Edward Longstreth Medal of Merit be awarded to Professor Dayton C. Miller, for his paper entitled "A 32-Element Harmonic Synthesizer," appearing in the January, 1916, issue, and his paper entitled, "The Henrici Harmonic Analyzer and Devices for extending and facilitating its Use," appearing in the September, 1916, issue of the *Journal* of The Franklin Institute, a comprehensive and lucid discussion of harmonic synthesis and analysis, together with descriptions of perfected apparatus for synthesizing and analyzing functions of one variable expressible by Fourier's equation.

THE AMERICAN CERAMIC SOCIETY AND MILITARY PREPAREDNESS

THE American Ceramic Society at its annual meeting held in New York, March 5 to 8, authorized the formation of a Committee on Military and Economic Preparedness, which has now been organized and has begun its activity. The committee has offered its services to the National Defense Council and the National Research Council.

This society devotes itself to the study of the chemistry and engineering of the silicate industries, embracing the manufacture of clay products, glass, cements and other cognate lines like the manufacture of abrasive wheels, the enameling of metals, etc. It does not deal with the artistic or historical phases as the name alone might lead one to infer. In its membership it has many of the leading specialists in the country, all of whom are eager to serve the country in this crisis. A census has been taken of the membership with a view to showing the number of firms and specialists available in each subdivision of the field, which have military significance.

Up to the present time eight divisions have been created which embrace in their membership leading manufacturers and technical men. The personnel of the committee is as follows:

Edward Orton, Jr., chairman, Ohio State University, Columbus, O.

A. V. Bleininger, vice-chairman, Bureau of Standards, Pittsburgh, Pa.

Divisions and chairmen of sub-committees:

Abrasives: R. C. Purdy, Norton Company, Worcester, Mass.

Chemical Stone Ware: R. H. Minton, Metuchen, N. J.

Enameled Iron and Steel: R. D. Landrum, Harshaw, Fuller & Goodwin Co., Cleveland, O.

Glass for Optical Purposes: C. H. Kerr, American Optical Co., Southbridge, Mass.

Hydraulic Cements: P. H. Bates, Bureau of Standards, Pittsburgh, Pa.

Porcelain, for Electrical Purposes, Spark Plugs, etc.: L. E. Barringer, General Electric Co., Schenectady, N. Y.

Raw Materials for the Ceramic Industries: A. S. Watts, Ohio State University, Columbus, O.

Refractories: A. V. Bleininger, Bureau of Standards, Pittsburgh, Pa.

WASHINGTON OFFICES OF THE NATIONAL RESEARCH COUNCIL

IN view of the present crisis, and at the request of the Council of National Defense, the Research Council has entered into close relations with the Defense Council, acting as a department of the latter. It is, in this capacity, charged with the organization of scientific research so as most effectively to contribute to national defense directly, and to the support and development of those industries affected by the war. The original organization of the Research Council, designed primarily for peace conditions, took the form of a number of subject committees, but this has been augmented by the addition of several special problem committees, the number of which will be increased as the necessity arises.

In order to carry out this scheme of cooperation the Research Council and several of its subcommittees have secured offices in the Munsey Building, Washington, D. C., where also are the headquarters of the Defense Council. The Research Council as a whole is represented by its chairman, Dr. George E. Hale, and by Dr. R. A. Millikan, the vice-chairman, charged with the correlation of research problems in general. The work has already grown to such dimensions that Dr. C. E. Mendenhall has been granted leave from the University of Wisconsin and has come to Washington to be associated with it.

The subcommittees are represented in Washington as follows:

Military: Dr. C. D. Walcott, chairman, Dr. S. W. Stratton, secretary, and other members representing various departments of the government.
Physics: Dr. R. A. Millikan, Dr. C. E. Mendenhall.
Chemistry: Dr. Marston T. Bogert, Dr. A. A. Noyes.
Medicine and Hygiene: Dr. Victor C. Vaughan.
Engineering: Dr. W. F. Durand.

As rapidly as possible these representatives are getting into touch with defense research problems through the military branches of the government, in which matter the military committee through its secretary plays an important part, and at the same time bringing these problems to the attention of the research men and organizations. The representatives in Washington will, among other things, act as a central clearing house for the reception of problems from the government, and their proper distribution; will sift, distribute and follow up suggestions of a scientific or engineering nature received from any source, individuals or groups; and will keep those who are working on specific problems informed as to the progress being made by others working along the same lines. It is the desire of the Research Council to do anything possible to stimulate scientific activity and aid in any possible way its direction and concentration upon the most vital and immediate problems. As one further means to this end, it will shortly have available for limited distribution to investigators especially concerned, brief statements of the various problems, and some account of the conditions under which these problems develop. The attention of research men should, however, be given not only to the solution of suggested problems and the development of suggested methods, but, obviously, also to the unearthing of new problems, which may be their most valuable service.

The National Research Council may be addressed at the Munsey Building, Washington, D. C.

SCIENTIFIC NOTES AND NEWS

DR. ARNOLD HAGUE, of the U. S. Geological Survey, distinguished for his work on the geology of the Yellowstone National Park and the Rocky Mountains, died at Washington on May 13 in his seventy-seventh year.

IN the last issue of SCIENCE it should have been stated that Professor A. A. Michelson, of the University of Chicago, had been elected vice-president of the National Academy of Sciences to fill the vacancy caused by Dr. Walcott's election to the presidency.

DR. D. T. MACDOUGAL, director of the Desert Laboratory, Carnegie Institution of Washington, Tucson, Arizona, has been elected president for the ensuing year of the Pacific Division of the American Association for the Advancement of Science.

DR. COLIN G. FINK, in charge of the research laboratory at the Edison Lamp Works, Harrison, was elected president of the American Electrochemical Society at its recent Detroit meeting.

AT its meeting of May 9, the American Academy of Arts and Sciences on the recommendation of the Rumford Committee voted that the Rumford Premium be awarded to Professor Percy W. Bridgman, of the Jefferson Physical Laboratory, for his "Thermodynamical Researches at Extremely High Pressures."

THE Academy of Sciences at Berlin has presented the Helmholtz medal to Professor R. von Hertwig, of the University of Munich, for his embryological researches.

THE Medical Society of London has awarded the Fothergillian Medal for 1917 to Sir Leonard Rogers, of the Medical College, Calcutta, in consideration of his work on dysenterics, their differentiation and treatment.

DR. ABRAHAM JACOBI was given a dinner on May 6 on the occasion of his eighty-seventh birthday by a group of New York physicians, most of whom had been his assistants.

A DINNER was given on May 5 in the Haverford College dining-hall in honor of Dr. Henry S. Pratt, professor of biology, who has been for over six months one of the district superintendents of food distribution in northern France.

DR. MARSTON T. BOGERT, professor of organic chemistry at Columbia University, has been given leave of absence to undertake special chemical research at the request of the National Research Council.

PROFESSOR WILLIAM D. ENNIS, since 1907 head of the department of mechanical engineering in the Polytechnic Institute of Brooklyn, has been appointed major in the ordnance section, Officers' Reserve Corps.

IN ACCORDANCE with the request of the National Research Council, the faculty of Wesleyan University have appointed the following local committee, consisting of one representative of each of the scientific departments of the institution with the president, William Arnold Shanklin, *ex-officio:* Professors Walter G. Cady, physics, chairman; William North Rice, geology; Raymond Dodge, psychology; Frederick Slocum, astronomy; Leroy A. Howland, mathematics; Moses L. Crossley, chemistry.

AMONG the committees working under the general direction of the Pacific Coast Research Committee of the Pacific Division of the American Association for the Advancement of Science, of which Dr. John C. Merriam, of the University of California, is chairman, is a committee on zoological investigations on animal food supply, composed of the following: Dr. Barton Warren Evermann, director of the Museum of the California Academy of Sciences, chairman; Dr. Charles A. Kofoid, of the University of California; Dr. Wm. E. Ritter and Mr. W. C. Crandall, of the Scripps Institution for Biological Research; Professors F. M. McFarland, Jno. O. Snyder and E. C. Starks, of Stanford University, and Mr. N. B. Scofield and Dr. Harold C. Bryant, of the California Fish and Game Commission. This committee is now active in making a survey of the native animal food supply (fishes, mollusks, crustaceans, mammals, etc.) of the state, for the purpose of determining the available supply and of devising ways and means for its increase.

DR. SAMUEL E. CHIU, a recent graduate of the Western Reserve Medical School, is now director of the department of dermatology, ophthalmology and Wassermann Laboratory of the Eden Dispensary, Shanghai, China, and reports he is organizing a modern hospital in Shanghai with nursing and medical schools.

MR. F. M. ANDERSON, for many years curator of invertebrate paleontology in the California Academy of Sciences, has resigned that position in order to devote his time to special work for the Southern Pacific Company, and Dr. Roy E. Dickerson, who has been assistant curator since 1914, has been appointed curator.

MR. W. P. FRASER, plant pathologist, of Macdonald College, has been appointed to investigate the problem of grain rust on the prairie provinces of Western Canada.

Dr. O. L. Fassig, in charge of the U. S. weather bureau station at Baltimore, has gone to San Juan on a special mission to extend and reorganize the weather bureau service in the West Indies. In the Virgin Islands a station is to be established, two stations are to be started in Haiti and one at Puerto Plata, Santo Domingo. The station in San Juan will probably be designated as the station in charge of the West Indies Service.

At the annual meeting of the Boston Society of Natural History on May 2, the following officers were elected: *President,* Edward S. Morse; *Vice-presidents,* Nathaniel T. Kidder, William F. Whitney, Charles F. Batchelder; *Secretary,* Glover M. Allen; *Treasurer,* William A. Jeffries; *Councillor for one year,* George H. Parker; *Councillors for three years,* Thomas Barbour, Henry B. Bigelow, John W. Farlow, S. Prescott Fay, Robert T. Jackson, John E. Thayer, Charles W. Townsend, William P. Wharton. In addition to the annual reports of the officers, the award of the Walker Prizes in Natural History was made. The first prize of $100 was given to Alfred C. Redfield, of Cambridge, for his essay on "The Physiology of the Melanophores of the Horned Toad"; the second prize of $50 was awarded Adelbert L. Leathers, of Olivet College, for his essay on "An Ecological Study of the Chironomidæ and Orphnephilidæ, with special reference to their Feeding Habits."

At the meeting of the New York section of the American Chemical Society held in Rumford Hall on May 11, the program consisted of a symposium on "Chemical Education and Its Relation to the Profession." The speakers were Raymond F. Bacon, director, Mellon Institute, "The Professional Status of the Chemist," and Herbert R. Moody, professor, College of the City of New York, "The Call for the Chemist."

At the meeting of the Geographic Society of Chicago on May 11, Dr. Henry C. Cowles lectured on "The Trees of California, a Riddle of Forest Geography."

The foundation stone of the Carmichael Hospital for Tropical Diseases was laid a year ago. We learn from *The British Medical Journal* that during the last year the hospital has been nearly completed, the donations, amounting to £5,000, for the construction of the top story having been provided by the Calcutta firms belonging to the Bengal Chamber of Commerce. The total subscriptions to the endowment fund have risen from £20,000 to £40,000, which will allow of the completion and partial endowment of the hospital, and, in addition, annual subscriptions of over £5,000 for research, contributed by the great industries of Bengal and Assam, will be available when the school can be opened—possibly in October, 1918. Meanwhile, plans are under consideration for the addition of 80 ft., to the height of three stories, to the north wing of the laboratory. This will accommodate an out-patient department and dispensary on the ground floor, and hygiene laboratories for practical and theoretical teaching for the university diplomas in public health. A full course for this diploma has not yet been provided in India, although instruction in the prevention of tropical diseases, which are the most important from the public point of view in India, can obviously best be imparted in such laboratories as that provided in the Calcutta School of Tropical Medicine. On the third floor there will be space for further research laboratories, which will soon be required on account of the success of the endowment fund in providing several research workers in addition to the goverment staff of the school. Omitting the cost of the biological laboratory of the Medical College, which has been included in the new building for administrative convenience, the Calcutta school possesses in its laboratory, hospital and endowments, property of the value of £90,000 of which £40,000 has been provided by the government of India on the advice of Sir Pardey Lukis, Director-General of the Indian Medical Service, and an equal sum raised by the endowment fund, of which Sir Leonard Rogers is the honorary secretary. The remaining £10,000 has been found by the Bengal government, whose finances have been severely handicapped by the war. It is hoped that the Bengal government will be able to contribute some substantial help towards the hygiene ex-

tension before very long, to enable it to be opened with the rest of the building after the war. This will complete the laboratories as at present proposed, although the foundations have been designed to allow a fourth story to be added at a later date, a wide view having been taken of the future possibilities of the institution.

UNIVERSITY AND EDUCATIONAL NEWS

STANLEY COULTER HALL, the new biology building at Purdue University, erected at a cost of over $100,000, will be dedicated on May 17. This building has been named in honor of Dean Coulter in recognition of his thirty years of scientific work in the university. The dedication will be held in connection with the spring meeting of the Indiana Academy of Science at Lafayette. Professor Wm. T. Sedgwick, the Massachusetts Institute of Technology; Dr. H. C. Cowles, the University of Chicago; Dr. Carl Eigenmann, Indiana University; President W. J. Moenkhaus, of the Academy; and J. S. Wright, Esq., of the alumni, will be the chief speakers.

WESTERN UNIVERSITY receives $20,000 by the will of the late William H. Burrows, a trustee of the institution.

THE late William H. Burrows, president of the Middletown National Bank, has bequeathed $20,000 to Wesleyan University, of which he was a trustee.

BY recent action of the board of trustees of the University of Chicago, the president of the university, on recommendation of the head of a department, will welcome doctors of philosophy of the University of Chicago and other universities as guests of the university, with the privilege of attending seminars and of carrying on research in the laboratories and libraries. There will be no charge except for laboratory supplies and a nominal laboratory fee where laboratory work is done.

LELAND STANFORD JUNIOR UNIVERSITY SCHOOL OF MEDICINE has adopted the quarter system, to begin on October 1, 1917. By the adoption of this system the school has a continuous session, any three quarters constituting a college year. The quarter system has been in effect at the Rush Medical College, Chicago, since 1899.

MORRIS M. LEIGHTON, Ph.D. (Chicago, '16), has been elected to the Washington Geological Survey for next year and to an assistant professorship in geology at the University of Washington, Seattle, to take effect on September 1, 1918. Dr. Leighton substituted at the University of Washington during the year 1915–16.

PROFESSOR FREDERICK B. LOOMIS, of Amherst College, has been appointed professor of geology to succeed Professor B. K. Emerson, who is retiring from active work.

DR. WILLIAM G. MACCALLUM, professor of pathology at Columbia University, has resigned to accept the chair of pathology and bacteriology at the Johns Hopkins University and Dr. Adrian V. S. Lambert, associate professor of surgery, has been designated to serve as acting head of the department, vacant by the resignation of Dr. George E. Brewer.

DISCUSSION AND CORRESPONDENCE

WHERE DO PITCHER-LEAFED ASH TREES GROW?

AT the New Orleans meeting of the scientific societies, in 1905, I reported the discovery of a group of pitcher-leafed ash trees (*Fraxinus americana*) near the Station for Experimental Evolution, Cold Spring Harbor, Long Island.[1] These trees had one or more leaflets of nearly every leaf—especially the terminal leaflets—formed into ascidia or so-called "pitchers."

This group of pitcher-leafed trees occupies a definitely circumscribed area, surrounded on all sides by trees with only normal flat leaflets, and I supposed, until a few months ago, that the pitcher-bearing trees were limited to this single small area, and the inference seemed justified that they had originated on this area by a comparatively recent mutation.

Two new localities for this peculiar form were discovered last fall in western Pennsylvania by Professor Charles W. Palmer, of the Westtown School, Westtown, Pennsylvania, and by a friend of his to whom he explained

[1] See SCIENCE, N. S., 23: 201, February, 1906.

the situation. These discoveries indicate that the pitcher-leafed type may be an older form than I had supposed, and that it may have a rather wide distribution. As the peculiar form of the leaflets is readily observed, especially on the young trees, the fact that the occurrence of pitchers in this species has never been published except by myself, and in relation to the trees at Cold Spring Harbor, would seem to indicate that this form probably does not occur in any considerable abundance over extensive areas.

In order to work out their probable evolutionary history, it is necessary to have more complete information regarding the present distribution of these pitcher-leafed ash trees. The reader is requested to assist in securing this information during the present spring and summer, by carefully examining as many young ash trees as may be accessible to him, and reporting the result to the undersigned, giving approximately the extent of area covered by the observations, and the number of *normal* ash trees observed, as well as the number of pitcher-leafed trees—if any of the latter should be discovered. A report is just as desirable in case only normal trees are found as if pitchered specimens are found. All communications should be addressed to

Geo. H. Shull

60 Jefferson Road,
Princeton, N. J.

"KEEP YOUR EYE ON THE BALL"

Evidently my last letter to Science[1] was not very clear and convincing, for Mr. Patterson[2] in a recent number insists on making the inertia-reaction of an accelerated body act upon the body itself and thus oppose the accelerating force. To him the term "unbalanced force" means "*a force opposed only by inertia-reaction.*"

In avoiding confusion as to the part played by this force of reaction in any case, I have found it useful to adopt a motto from the royal game of golf—"Keep your eye on the ball." When a ball is swung on the end of a cord, the centripetal force exerted by the stretched cord *on the ball* is unbalanced and produces the centripetal acceleration of the ball. There is the whole story as far as the ball is concerned. The inertia reaction of the ball acts *upon the cord* and through the cord acts *upon the hand.* The law of motion states that the rate of change of momentum of any body is at each instant proportional to the resultant of all the forces acting upon that body. In applying the law to a given body A, keep your eye on A and consider only the forces acting upon A. Among these forces, the inertia-reaction of A is never to be included since it always acts upon some other body or bodies.

Mr. Patterson would have us believe that inertia-reaction and friction are not full-fledged forces in the single definite sense implied in the laws of motion. He says neither can produce positive acceleration. Let us see if this is true.

Consider the experiment in which two masses, connected together by a string and free to slide along a horizontal rod, are rotated about a vertical axis. If the distances from the axis are in the right ratio, the masses will rotate without sliding, the inertia-reaction of each mass accelerating the other.

Then take the case of a passenger leaning forward as he stands on a starting train. The forces acting *on him* are his weight, the upward elastic reaction of the floor which balances his weight, and friction. He is being accelerated, and friction is doing it.

Even though some forces are always pulls, others always pushes, and others neither, we need not differentiate between them since each tends to produce acceleration in a certain direction.

Let us agree, then, that a body can not exert a force upon itself; that all forces are similar in their effects; and that in applying the laws of motion to any body, care should be taken to consider only the forces acting upon it.

Gordon S. Fulcher

Wisconsin University,
March 24, 1917

1 "Can a Body Exert a Force upon Itself?" Science, Vol. XLIV., p. 747, 1916.

2 "When Is a Force Not a Force?" Andrew H. Patterson, Science, Vol. XLV., p. 259, 1917.

THE TENTH-EXPONENT

A METHOD of expressing large or small quantities in modern physical and chemical science is to write the number expressing the quantity as a factor of some power of 10. It is proposed to change this notation and write the exponent of 10 at the upper left-hand side of the factor and call this exponent *The Tenth-Exponent*. The base, 10, is omitted. The following numbers will illustrate this notation:

$1.872A \times 10^{3} = {}^{3}1.872A$, number of electrons in any atom, $A =$ At. Wt.

$1.49 \times 10^{-17} = {}^{-17}1.49$ ergs, average kinetic energy of the electrons in the H atom at 0° C.

$3.4 \times 10^{10} = {}^{10}3.4$ cm./sec., *mean square* of the velocity of the electrons in the H atom at 0° C.

$4.0 \times 10^{13} = {}^{13}4.0$ cm./sec., *mean square* of the velocity of the electrons in the H atom at 3000° C.

$v/(6.062 \times 10^{23}) = v/{}^{23}6.062$ cm.,^{3} the volume required by any atom,

$$v = A/D;\ D = \text{density}.$$

$6.062/v \times 10^{23} = {}^{23}6.062/v$ number of atoms of any element per cm.^{3}

FRANK W. BALL

CHEMICAL PUBLICATIONS

TO THE EDITOR OF SCIENCE: On page 169 of the current volume of SCIENCE (February 16, 1917), I note that the table gives in 1914–15, 29 publications on chemistry from Columbia University, and 6 under Columbia University and Roosevelt Hospital. The work of these six papers was all done in this department, and should therefore have been included in the table. This would change the number on page 170 for Columbia University from 29 to 35, and would place this department, as regards the number of articles, eighth on the list instead of tenth. It should be noted also that this table refers only to publications in American journals. A number of papers were published in foreign journals from this department during the same year.

ALEXANDER SMITH

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QUOTATIONS

SCIENTIFIC AND CLASSICAL EDUCATION

IF scientific men who have not had the time to follow up this educational controversy closely wish to grasp its essential values, they can not do better than weigh over the implications of this passage that follows, from an article by Lord Bryce in the current *Fortnightly Review:*

> I do not contend that the study of the ancients is to be imposed on all, or even on the bulk, of those who remain at school till eighteen, or on most of those who enter a university. It is generally admitted that at the universities the present system can not be maintained. Even of those who enter Oxford or Cambridge, many have not the capacity or the taste to make it worth while for them to devote much time there to Greek and Latin. The real practical problem for all our universities is this: How are we to find means by which the study, while dropped for those who will never make much of it, may be retained, and for ever securely maintained, for that percentage of our youth, be it 20 or 30 per cent. or be it more, who will draw sufficient mental nourishment and stimulus from the study to make it an effective factor in their intellectual growth and an unceasing spring of enjoyment through the rest of life? This part of our youth has an importance for the nation not to be measured by its numbers. It is on the best minds that the strength of a nation depends, and more than half of these will find their proper province in letters and history. It is by the best minds that nations win and retain leadership. No pains can be too great that are spent on developing such minds to the finest point of efficiency.
>
> We shall effect a saving if we drop that study of the ancient languages in the case of those who, after a trial, show no aptitude for them.

Let the scientific man read that over carefully, and, if need be, re-read it. Let him note first the invincible conceit of the classical scholar in the superiority of his particular education to any other, and his firm determination *to secure the pick of the available boys and the pick of the administrative posts* for the classical training. Science and research are to have those rejected as unfit in this sublime progress of the elect. Instead of our boys—I mean the boys destined for real philosophy, living literatures, science, and the study of actual social and political questions —having a straightforward, well-planned

school course, they are to be *tried over* at Greek for just the most precious years educationally, and our modern world is to have the broken fragments. This claim is pressed even more impudently by Mr. Livingstone in his recent "Defense of Classical Education." He insists that all our sons are to be muddled about with by the teachers of Greek up to at least the opening of the university stage, entirely in the interests of Greek scholarship. Professor Keeble's dream of "sweet reasonableness" is a mere dream. These classical people are absolutely ignorant of their own limitations; they can imagine no compromise; they mean to ram compulsory Greek down the throat of every able English boy they can catch, and they mean to load the scales in favor of Greek at any cost to science, philosophy and national well-being.—H. G. Wells in *Nature*.

SCIENTIFIC BOOKS

Human Physiology. By Percy G. Stiles. Philadelphia, W. B. Saunders Company, 1916. Pp. 405.

The announcement in the preface, the "purpose is to present concisely the accepted facts with only a limited description of the experiments by which these facts have been established," gives an idea of the scope and nature of the book. There is the further qualification that books of this sort are at fault if they do not make it plain that "unsettled questions confront the investigator at every turn."

Little of historical importance is mentioned, the omission being purposeful. It is an open question in the mind of the reviewer whether the student should not have some knowledge of the history of science as well as of wars and "low ambition and the pride of kings." If necessary, low ambition could be found in the history of science.

While strongly inclined to view with great charity the author's confession of a feeling akin to guilt because he has not acknowledged all the illuminating ideas and happy teaching devices which he owes to his contemporaries, the reviewer can not wholly suppress the wish that such a feeling might become highly contagious and assume a grave form among authors of text-books and the writers of papers generally. The full acknowledgment of such obligations might dim individual brilliance at times, but science would not be the loser thereby. The author's "atonement" might have been more complete if he had included the works of Ott, Stewart and Tigerstedt (English translation) in the list of collateral readings at the end of the book.

In the brief statements of a historical nature on pages 15 and 16, one finds but little mention of the influence of French investigators in physiology. A statement of Professor Howell is so pertinent in this connection that I venture to quote it.

> The establishment of physiology as an experimental science is usually attributed to Johannes Müller and his pupils or their contemporaries who fell under his influence. But as I read its history, its modern characteristics, whether for good or for evil, owe their origin as much to the French as to the German school. Johannes Müller himself was not preeminent as an experimenter—he made use of anatomical rather than physiological methods; but his contemporary Magendie was a typical modern physiologist, and whatever may have been the extent of his personal influence during life, there can be no question that his methods of work and his points of view are the ones that were subsequently adopted in physiology.

On this point, the reviewer is in full agreement with Howell. In the present world conflict of ideals and ideas, even such minor considerations as these should not be wholly lost sight of.

One departure from the usual method of treatment is found on page 95. In the legend of Fig. 22 the author states that the coordinating center for the reflex, a part of whose path is shown, is left undetermined. Evidence is accumulating that the location of the coordinating center for a reflex varies for different reflexes in the same animal, and for a reflex of essentially the same nature in different species of animals.

One might take exception to the statement on page 116 that "We are not usually aware of the nerve currents that arrive in the cen-

tral nervous system from the labyrinth." Crum Brown's statement of the function of the semicircular canals was "the perception of the change of aspect of the head in space." This statement has stood the test of criticism and one usually is aware of the change of aspect of the head in space.

The easy-going husband and the nagging wife find their counterpart in the ventricles and the auricles of the heart, p. 257. A declaration of independence on the part of either husband or ventricle leads to domestic infelicity.

On the whole, the book fulfills its particular purpose better than any other with which I am familiar. Writing such a book is a particularly difficult task, and the author has succeeded better than most. There are many new diagrams of unusual clearness.

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GOODALE'S EXPERIMENTS ON GONADECTOMY OF FOWLS

IT has long been known that the removal of the testes of the male fowl does not affect materially the complete development of the secondary sexual characters of the cock, although a critical examination of the results has been much needed. The change of the hen's plumage into that of the cock, a change that occasionally takes place in old age, or when the ovary has become diseased, is also a matter of record, but the evidence for this has been rather anecdotal than detailed. Both changes have now been carefully studied by Goodale in a series of carefully planned experiments carried out through a series of years, mainly at the Station for Experimental Evolution of the Carnegie Institution. The results[1] have been published recently by the Carnegie Institution. The excellent colored drawings that illustrate the results greatly enhance their value.

The operation was made on Rouen ducks as well as on fowls (Brown Leghorns) and the results are in agreement in all essential respects. Complete removal of the testes either from very young, or even from older birds, does not cause any lessening of secondary sexual plumage, although in a few points the capon differs in plumage slightly from the normal cock and in a few minor points also other than plumage. The complete removal of the ovary of the birds is an extremely difficult operation and is rarely entirely successful. Failure to remove all of the tissue gives an opportunity for regeneration of the gland, which completely nullifies the attempted experiment. When removal of the ovary was complete (as shown by subsequent dissection) the duck and hen assumed the male plumage. When the very great differences in the plumage of the Brown Leghorn hen and cock and of the Rouen duck and drake are recalled, the change is startling; for it involves not only the transformation of the brown plumage of the hen into the brilliant red and black of the cock, but involves likewise a change in the shape of many of the feathers, notably those of the hackle, back, saddle and shoulder as well as minute details in the barbules. Goodale exhibited such a cock-feathered hen at the Christmas meeting of the Naturalists, as well as one case in which the testes had been removed from a young cock and an ovary engrafted in their place. The presence of the latter had prevented the cock, when adult, from developing the characteristic male plumage. He resembled a hen in essentially all plumage characters.

Into the details of the work it is not possible to enter here—details that involve the effect of incomplete gonadectomy, the possible influence of other organs in the neighborhood of the gonad, the relation between the juvenile plumage and that of the adult female, and in the case of the ducks the effect of gonadectomy on the nuptial and eclipse plumage. Several results here obtained are entirely new and a number of problems raised heretofore unsuspected.

[1] "Gonadectomy in Relation to Secondary Sexual Characters of Some Domestic Birds," H. D. Goodale, Carnegie Institution of Washington, 1916, No. 243.

The comb of the capon fails to reach the full development of that characteristic of the Brown Leghorn cock, while in the spayed female the comb becomes male-like in certain individuals at least. The spurs develop on the capon as well as on the cock—a result that shows that this secondary sexual character at least is little if at all affected by the removal of the testes. In the Brown Leghorn hen and more commonly in other breeds, spurs may occur on the female occasionally, and even be developed as completely as in the male, but they developed *in all* the successfully spayed females. In the light of the occasional occurrence of spur in the female, the results after spaying can not be definitely ascribed to the absence of the ovary, although this is the more probable conclusion.

In castrated drakes and in spayed ducks the voice remains normal "except that some castrated females occasionally give voice to a sound similar to the drake's." In fowls, on the other hand, both sexes after gonadectomy "are disinclined to give voice," although capons may give all the sounds characteristic of clarion (but rarely do so). The spayed females were not observed to crow.

At the time when Goodale's paper was written the effect of castration on hen-feathered males (that are characteristic of certain races, notably Sebrights, Hamburgs and Campines) was not known. Since then the reviewer has shown that not only the F_1 (dominant) and F_2 hen-feathered males assume the full plumage of the cock, but that this holds true for the pure Sebright cock also.

Goodale discusses the nature of the influence that brings about the change after removal of the ovary and concludes that the ovary secretes some substance that holds in check the development of full male characters that may be assumed to be inherited through *both* sexes. A parallel case is furnished by the experiments referred to above, in crosses of Sebrights and Black Breasted Game Bantams, that show that hen feathering is transmitted as a non-sex-linked character both by the hen and by the cock. Cock feathering develops in the hen-feathered cock after castration, as well as in the hen when old (according to a brief notice by Darwin in "Animals and Plants," Chapter XIII., Vol. 11, p. 29). The probable nature of such an internal secretion is discussed by Goodale in the following significant statement (page 49):

> The adjustment of the ovarian secretion to the characters it modifies is very close, as shown by the fact that the male characters produced in a given female are like those of the corresponding male. . . . From this we may conclude that the secretion on the whole is relatively simple and probably of uniform nature. If the secretion were composed of many substances, one to produce each effect involved, such as the change from a vermiculated feather to penciled, from a gray and white to a black and brown, the resulting complexity would be so great that one would not anticipate any such close coordination as actually results. For purposes of illustration we may assume that the ovarian secretion is simple, producing its effect by oxidation or some other simple process. The sort of result produced by oxidation, of course, depends upon the substance that is oxidized.

It need scarcely be added that this statement furnishes no grounds for the identification of the enzyme produced in the testes with the factor or factors that represent it in the sex chromosome, viz., the sex-determining factors. It is possible, of course, that the sex factors are enzymes, but there is not the slightest warrant for drawing the conclusion that they are (as some recent writers have done) from genetic evidence of this kind, for it is also possible that there may be a long series of reactions between the chemical substance in the chromosome that we may identify if it pleases us to do so as the genetic factor, and the enzyme that develops later when the testes are formed.

T. H. Morgan

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SPECIAL ARTICLES

THE BEHAVIOR OF CERTAIN GELS USEFUL IN THE INTERPRETATION OF THE ACTION OF PLANTS

The amorphous carbohydrates constitute a very important part of the colloids of the

protoplast, the remainder of which consists largely of nitrogenous material, in the form of albumen or albumen derivatives with an unknown amount of lipin. The search for material which might simulate the imbitional behavior of growing tracts in plants begun by the senior author resulted in finding that mixtures of agar with gelatine in which the last-named substance was present in the smaller proportion showed an enhanced capacity for imbibition in distilled water and a reduced swelling in weak acid and alkali as measured in very thin plates by the auxograph.[1]

It is not certain, however, that the combination of amino-acids in gelatine is duplicated in the plant and it was deemed important to test the effects of simpler amino-acid compounds and of the more complex albumens on the swelling of agar, as representing the basically important carbohydrates. Solutions of the various mixtures were poured on glass plates in layers about a centimeter thick and 3 by 5 cm. in area. Desiccation resulted in a reduction of the length and width to about half of the original. The thickness, however, was reduced to one tenth or even as much as to one thirtieth of the original, and having a thickness of .1 mm. to .3 mm. in most cases. The principal axis of deposition of material was in the vertical and the swelling in this direction would of course be correspondingly in excess of that in the plane of the sections. It is extremely unlikely that any of the colloidal masses of the cell are iso-radial as to deposition or structure and the use of thin plates seemed a feature which might increase the similarity of behavior with that of the plant. The strands, sheets or masses of material in the cell are of course mostly thinner than the plates used in the experiments, which however, would affect speed of imbibition more than total amount.

Trios of sections of sheets of the dried colloids 2 to 4 mm. by 3 to 6 mm. were placed in the bottom of stender dishes or of heavy watch glasses securely seated on iron cylinders. Triangles of glass were placed on the sections, and the vertical arms of auxographs were rested in a socket in the center of the triangles. Any change in thickness of the sections would be registered immediately. The use of six instruments gave duplicate results of the effects of water, acid and alkali, and each record was an integration or average of the swelling of three sections.

The only albumen available when this plan was put into operation was a commercial egg-albumen, and this was first tested in mixtures with large proportions of gelatine. The results of the swellings are as follows:

Water	HCl $N/100$	NaOH $N/100$
	Gelatine (Average of 3 tests)	
313.8%	825.5%	558.3%
	Gelatine 100—Albumen 5 (Average of 5 tests)	
283.4	611.7	482.2
	Gelatine 85—Albumen 15 (Average of 5 tests)	
408.6	827.8	673.0
	Gelatine 75—Albumen 25 (Average of 3 tests)	
378.3	569.7	508.7

The albumen did not exert any important influence on the swelling of the mixture until it was present in proportions as great as 25 per cent. The action is not marked even in this high proportion. Neither this nor any other combination in which gelatine formed the greater part displayed water relations at all similar to those of the plant.

Next egg-albumen was added to agar and agar-gelatine mixtures with results as below, a further illustrative test being made of agar-gelatine:

Water	HCl $N/100$	NaOH $N/100$
	Agar 75—Gelatine 25 (Average of 4 tests)	
378.5%	427.3%	515.7%
	Agar 90—Albumen 10 (Average of 3 tests)	
1,516.6	270.0	333.3
	(Average of 6 tests)	
1,477.1	309.8	297.9
	Agar 90—Gelatine 10	
595.0	216.6	298.6

The addition of ten per cent. of albumen to agar notably reduced the capacity of agar for swelling in acid and alkali, and appeared to

[1] MacDougal, "The Imbibitional Swelling of Plants and Colloidal Mixtures," SCIENCE, N. S., Vol. XLIV., pp. 502–505, 1916.

increase the amplitude of swelling in distilled water, although the last matter is not entirely clear. The albumen reduced the swelling of a mixture containing twenty-five per cent. of gelatine slightly in acid and in alkali, but the swelling in water was not markedly greater. This preliminary test yielded results which made their extension highly desirable. Chemical analyses of the egg-albumen were not available, and as nothing was known as to the salts or other substances which might be included, it was desirable to secure material of known origin and composition. Arrangements were made with Dr. Isaac F. Harris, of Squibb and Sons Laboratory, New Brunswick, New Jersey, to prepare some albumen from beans (*Phaseolus*) and from oats (*Avena*) to be used in the mixtures. The preparations from *Phaseolus* were available in February, 1917, and the first tests were made with the "protein" extract.

Agar and gelatine were dissolved in the usual way and the temperature of the solution allowed to fall to a point below 40° C. before the protein was stirred into it. In the course of the cooling and drying cloudy masses became visible which were taken to be the globulin component of the protein. The dried sheets came down to a thickness of .3 to .4 mm. Calibrated samples were tested in trios under the auxograph in the usual manner. Two complete series of all mixtures were made and an additional measurement of the action of water and alkali were obtained. The swellings were as follows:

	Water	HCl $N/100$	NaOH $N/100$
	Gelatine 90—Protein 10	*(Phaseolus)*	
	585.7%	1,401.0%	942.8%
	486.0	1,200.0	704.3
	386.0	———	800.0
Averages:	485.9	1,300.5	817.7
	Gelatine 75—Protein 25	*(Phaseolus)*	
	696.9	818.1	621.2
	500.0	1,060.6	848.4
Averages:	598.5	939.4	734.8
	Agar 90—Protein 10	*(Phaseolus)*	
	800.0	50.0	150.0
	800.0	75.0	150.0
Averages:	800.0	62.5	150.0
	Agar 99—Protein 1	*(Phaseolus)*	
	1,080.0	300.0	220.0
	800.0	360.0	240.0
Averages:	940.0	330.0	230.0

The protein extract from the bean was thus shown to exert an influence on the swelling of agar similar to that of egg-albumen in reducing the amount of swelling in acid and alkali, and increasing it in distilled water.

The next step of importance was to ascertain the effect of some of the simpler amino-acids which might be derived from the albumens in the plant. Tyrosin and cystin were available. As an example of the method the first preparation of tyrosin was one in which one part of this substance in solution was stirred into a liquefied mass of ten parts of agar at a temperature of 32° C. This was poured on a glass slab, and as desiccation was carried out the tyrosin began to collect as a flour-like efflorescence on the surface, and apparently a large part of the substance came out in this way, so that the actual proportion of the amino-acid in the dried plate was probably not more than a fourth of the amount originally used.

The dried plate of material came down to a thickness of .15 mm. and gave the following results:

SWELLING

	Water	HCl $N/100$	NaOH $N/100$
	Agar 90—Tyrosin 10	*(less by efflorescence)*	
	1,600.0%	133.3%	133.3%
	1,200.0	233.3	100.0
Averages:	1,400.0	183.3	116.6

A similar preparation of agar and cystin gave the following as an average of three tests:

Water	HCl $N/100$	NaOH $N/100$
	Agar 90—Cystin 10	
2,333.3%	583.1%	328.6%

A similar mixture of agar and urea (agar 90 parts, urea 10 parts) gave the following:

Water	HCl $N/100$	NaOH $N/100$
	SWELLING	
2,173.0%	716.6%	560.2%

Urea, the amino-acids, gelatine, albumen, and the saline soluble proteins of the bean dissolved with agar and dried into thin plates show a greatly enhanced imbibition in water, an imbibition in hundredth-normal hydrochloric acid not more than a third of that in

water, while it is invariably less in alkaline than in acidified solutions. The interest in swelling which begins with a neutral desiccated section is, however, much less than that which attaches to the behavior of such material under changing conditions of alkalinity and acidity which are taken to occur in the living plant.

Dried plates of agar-protein, agar-tyrosin and agar-cystin .12 to .25 mm. in thickness and 3 by 4 or 5 mm. were placed in trios on the bottoms of stender dishes. Triangular pieces of glass were placed to cover the sections of colloid in each dish and an auxograph was arranged to give a bearing contact of the swinging arm on a socket in the center of the triangular plate. So long as the preparation remained in this condition the pen of the instrument traced a horizontal line on the sheet carried by the drum. Dried sections of the colloids have a very limited capacity for imbibition of acid and alkaline solutions, and hence it was desirable to start swelling or "growth" by an initial immersion of an hour in distilled water, which was poured in the dishes. After enlargement had begun hundredth-normal acid or alkaline solutions were used in alternation at intervals of one to three hours, as many as four changes being made in some cases before the total swelling capacity was reached. The results met all expectations based on theoretical considerations and the auxographic tracings might easily be mistaken for records of the variations of the length of a joint of *Opuntia*, for example.

Sections of plates 90 parts agar to "10" of tyrosin gave a tracing traversing 12 mm. vertically on the record paper during the first hour immersed in distilled water, remained stationary, making a horizontal line during the second hour, the water having been replaced with hundredth-normal hydrochloric acid, traversed 11 mm. of the scale in the third hour during which it was immersed in hundredth-normal sodium hydrate, then shrunk 5 mm. in an hour in acid, then enlarged 9 mm. in three and a half hours in alkali, after which it shrunk 3 mm. between 8:30 P.M. and 7 A.M. in acid. A change to alkali gave an enlargement of 6 mm. in two hours. The auxograph was set to multiply so that the actual enlargement in the periods noted was one twentieth of the distance traversed by the pen. The change from acidity to alkalinity is followed by the most marked effects when the colloid has taken up a fourth or a third of the possible total amount of water. Perhaps the most striking feature is the response of the colloid to acidification under the alternating conditions. Desiccated sections give a greater total swelling in acid than in alkali, but when a certain amount of swelling has already taken place under neutral or alkaline conditions no further increase in acid solutions takes place and actual shrinkage ensues. A change to alkalinity is always followed by increased imbibition.

The experiment in question has many features similar to those of the plant. Changes from alkalinity to acidity and the reverse must be made quickly to avoid instrumental error, consequently some acid or alkali is not removed from the dish. The plate of swelling colloid is saturated with the liquid which is being removed and neutralization, acidification or the reverse does not occur for some time. Such conditions prevail in the plant and come about even more slowly.

The disintegration of the acid of *Opuntia* beginning at daybreak does not overtake the formation of this substance until as late as 4 P.M. Whether complete neutralization or alkaline conditions ever occur in this plant is doubtful. There is ground for the assumption that it does in other plants, however.

The almost rhythmic undulations of the auxographic tracing of the elongation of a wheat leaf corroborated by measurements with the horizontal microscope suggest that growth in this organ may be accompanied by metabolic processes by which the balance of acidity and alkalinity falls now on this and then on that side, there being of course possible periods in which the growing protoplasts, or some of them, were in a neutralized state. During this time, of course, imbibition might be four to eight times as great as in either acid or alkaline conditions.

The systematic endeavor to construct a colloidal mixture which would display some of the fundamental physical properties of protoplasm of plants has resulted in finding that a mixture of substances of two of the three more important groups of constituents, carbohydrates and proteins, shows the imbibitional behavior of tissues and tracts of protoplasts of the plant. The differential action of such colloidal masses in distilled water, acid and alkaline solutions yields many striking parallels with growth. The general identity of constitution of these colloidal mixtures and of cell-masses, and the obvious similarity of their behavior, together with newly determined features of carbohydrate metabolism not described in this paper, make it possible to correlate more closely the processes of imbibition, metabolism and growth, and on the bases of their interrelation, to interpret growth enlargement and incidental variations in volume and size of organs.

D. T. MacDougal,
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SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

A regular meeting of the society was held at Columbia University on Saturday, April 28. The attendance included twenty-seven members. Professor E. W. Brown presided at the morning session and Professor Edward Kasner at the afternoon session. The council announced the election of the following persons to membership in the society: Professor C. F. F. Garis, Union College; Professor F. J. Holder, University of Pittsburgh; Dr. V. H. Wells, University of Michigan; Professor W. L. Wright, Lincoln University, Pa. Six applications for membership were received.

Professor L. P. Eisenhart was reelected a member of the editorial committee of the *Transactions*. A committee consisting of Professors Focke, Cairns, Cole, Huntington, Pitcher and D. T. Wilson was appointed to have charge of the arrangements for the summer meeting of the society at Cleveland, September 4–5.

The following papers were read at this meeting:

W. B. Fite: "The relation between the zeros of a solution of a linear homogeneous differential equation and those of its derivatives."

Samuel Beatty: "The inversion of an analytic function."

Maurice Fréchet: "Relations entre les notions de limite et de distance."

O. E. Glenn: "A fundamental system of formal covariants mod 2 of the binary cubic."

Luigi Bianchi: "Concerning singular transformations B_k of surfaces applicable to quadrics."

J. E. Rowe: "The projection of a line section upon the rational plane cubic curve."

L. B. Robinson: "On partial differential equations which define certain covariants."

J. K. Whittemore: "Kinematic properties of ruled surfaces."

Olive C. Hazlett: "On Huntington's set of postulates for abstract geometry."

E. F. Simonds: "Differential invariants in the plane."

J. Douglas: "On certain two-point properties of doubly infinite families of curves on an arbitrary surface."

L. P. Eisenhart: "Conjugate planar nets with equal invariants."

Alexander Pell: "Solutions of the differential equation $dx^2 + dy^2 + dz^2 = ds^2$ and their application."

C. A. Fischer: "On bilinear and n-linear functionals."

E. B. Wilson: "Classification of real strains in hyperspace."

F. H. Safford: "Irrational transformations of the general elliptic element."

J. H. Weaver: "Some algebraic curves."

R. L. Moore: "A necessary and sufficient condition that a sequence of simple arcs of specified type should be equivalent, from the standpoint of analysis situs, to a sequence of straight segments."

Dunham Jackson: "Second note on the parametric representation of an arbitrary continuous curve."

Dunham Jackson: "Roots and singular points of semi-analytic functions."

Oswald Veblen: "Doubly oriented lines."

G. M. Green: "The intersections of a straight line and a hyperquadric."

F. W. Beal: "On a congruence of circles."

G. A. Miller: "Possible characteristic operators of a group."

R. D. Carmichael: "Examples of a remarkable class of series."

W. L. Hart: "Note on infinite systems of linear equations."

F. N. Cole,
Secretary

SCIENCE

FRIDAY, MAY 25, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SOME RELATIONSHIPS OF CHEMISTRY AND LIFE[1]

ABOUT the middle of last century Huxley and his co-workers clearly recognized the place of science in education, and the relation of both to life, and urged upon the world the necessity of scientific knowledge. Meanwhile, the schools and colleges have tried the experiment and have been convinced, but it has taken the present war with its terrible toll of death and destruction to focus the attention of the masses in a way which a century of reasoning has failed to do. This is not the place to discuss either of these experiences in detail, and I shall content myself by giving the conclusions of one competent witness who has watched the entire progress of the experiment.

After more than fifty years of continuous study of the education problem, Ex-President Eliot, of Harvard, concludes that the present generation is characterized by two strong desires. The first is a desire for a sound knowledge of the facts, and the second is an intense desire to be of service to mankind. If these conclusions are well founded, education must provide for their realization if it is to be successful in the broadest sense. This program, of course, is but another way of stating the scriptural text, "Know the truth, and the truth shall make you free." For the purpose of this address no better text could be found, for these words sum up as clearly as can be done the place of the scientific method in the learning process, and the relation of science to life as a whole.

[1] Address delivered on the occasion of the dedication of the chemical laboratory of the University of Oklahoma, January 26, 1917.

The necessity of realizing these relationships in everyday life has been persistently urged for two generations by men of science, but it has taken the present world crisis and its consequent interruption of our commercial relations to show how much more should have been done. The preparedness programs of this and other nations, as well as the utterances of thoughtful men in responsible positions in various walks of life, bids us hope that the lesson has now, in a measure, been learned. In a recent address before the British Association for the Advancement of Science an able chemist says:

> The press bears witness through the appearance of innumerable articles and letters that the people of this country have begun to perceive the dangers that will inevitably result from a continuance of their former attitude, and to understand that in peace, as in war, civilization is at a tremendous disadvantage in the struggle for existence unless armed by science; and that the future prosperity of this empire is ultimately dependent on the progress of science and very especially of chemistry. If, as one result of the war, our people are led to appreciate the value of scientific work, then perhaps we shall not have paid too high a price. (The same view has been expressed by many eminent American chemists.)

A similar note of warning is sounded by a continental writer in discussing the question of whether we shall have a precarious or a lasting peace. He says:

> It would be a dangerous mistake to suppose that any readjustment of frontiers could afford a sufficient guarantee for future peace, or that war indemnities, protective tariffs and the like could oblige the peace-breakers to renounce their schemes. . . . At the future (*peace*) congress, among the seats reserved for the delegates of the Great Powers, one seat should remain vacant, as reserved to the greatest, the most redoubtable, though the youngest of Powers: Science in scarlet robes.[2]

Before taking up a discussion of the relationship of chemistry and life, it may be worth while to inquire as to the general attitude of the public toward the work of the chemist. If you ask the first person you meet, or if you get the opinion of the newspaper man or other influential citizen, about the work of the chemist, he is apt to tell you that the chemist is a man who can analyze substances, and detect falsification in them; but he is not likely to tell you that the chemist has any important relationship to the commercial development of the enterprise in question. How many in this audience, for example, think of the chemist when they pour their "Karo" on their hot cakes at breakfast, when they read the headlines of the daily paper and learn that a wireless message has been flashed across the ocean; when they step into an automobile to start the day's work, or when, the work completed, they while away the time of the evening watching the screen in some motion picture show? Nevertheless, in the successful working out of each of these the chemist has played an important and, in some cases, a vital part, but I have not time here to give particulars.

Let me give you a concrete example of what I mean. Whenever one thinks of the Panama Canal one's thoughts turn at once to the chief engineer, Col. Goethals. He is the one to receive the medals, the honorary degrees, the thanks of Congress, the promotion to higher rank in the army, and finally to be named governor of the Canal Zone. Do not misunderstand me: I am not complaining of this recognition of the man's undoubted merit, because Goethals was unquestionably the moving spirit in the undertaking, and certainly worthy of all the honors that have come to him. But when we come to survey the case a little more closely, we see that there are at least three other factors for neither of which Goethals was personally responsible, but without the support of any one of which he

[2] Reinach, S., *Nation*, June 15, 1916.

would have been absolutely helpless. The first of these is the health of the laborers. The French undertook to build the canal years ago, and while their failure was brought about by several causes perhaps one of the most important was the fact that the men could not live in that part of the world and retain their health. Yellow fever and malaria were everywhere, and it was but a matter of time when one must be attacked by one or both of these infections. It has been stated that the building of the railroad across the Isthmus meant the death of a man for every tie that was laid. But man can live in Panama now with perfect safety, so far as yellow fever is concerned, and this is due entirely to discoveries with which Col. Goethals had nothing to do. Dr. Gorgas was in immediate charge of the work of sanitation, but it was kerosene, the product of the chemist, which was sprayed on the stagnant pools, and which checked the development of the mosquito.

In the second place, the penetration of Culebra, as well as the remainder of the blasting necessary, would have been impossible without the powerful explosives of the chemist. The gun-powder, dynamite, blasting gelatin and similar substances are all products of the chemical laboratory.

In the third place, let us suppose that the development of the mosquitoes has been checked, that Culebra has been pierced—the work is only half done. It is necessary to control the level of water in the canal, and this, under the conditions imposed, can be done in only one way, namely, by the construction of locks and dams. For these some material stronger than wood and less easily corroded and destroyed than iron must be used, and this is found in the chemist's cement. As is well known, thousands of barrels of this material were used in the work.

Finally, when the canal is complete and ships are passing back and forth through it, there is comparatively little safety until it has been fortified. The chemist's powder and steel must stand guard over it as they do over every treasure we own, or we should not be able to retain it as a national possession.

Cases of this kind could be multiplied indefinitely, but I must not take your time to do so. On the other hand, the Panama Canal is so remote that many persons do not think of it as having any bearing whatever on their daily lives. But the question of food and war munitions at this time can hardly be misunderstood by any, and it remains merely to show the relations of chemistry to these to convince the most indifferent. A detailed discussion of even these would tax your patience, I fear, therefore I shall limit myself to the consideration of a single element, viz., nitrogen.

It has long since been proved that nitrogen is an essential constituent of the food of all living beings, and that, in general, it may not be assimilated if taken directly from the air where it is present in the free form. It must be combined with one or more other elements. As one begins the study of nitrogen in a chemical laboratory, he finds what at first sight appears to be a relatively uninteresting element. It has neither color, odor nor taste, is but slightly soluble in water, and does not readily combine directly with other elements. But in combination it is a constituent of many different substances of the most varied characters. It is present in some of the most delicate of perfumes as well in substances whose odors suggest utter vileness. It is a constituent of various fibers (wool, silk, artificial silk) used in our clothing, and also of the aniline dyes which enhance their beauty and value. It is present in the most potent of medicines and in the most deadly poisons. As gunpowder it drives our bul-

lets, as dynamite it explodes our mines, and as cyanide it extracts our gold. Under the general name of protein it is an indispensable element of animal food, and as animal waste, it is returned to the soil as food for plants. Thus, nitrogen not only gives life, health and prosperity, but it is the most terrible element of death and destruction known to modern warfare.

In considering nitrogen as an element of food, we may note in passing that the normal adult human body requires a certain amount of the element every 24 hours, and that this must be supplied in the form of meat, eggs and various vegetables, all of which are either directly or indirectly products of the soil. Now, every one knows that continual cropping causes a soil to become poor, and chemical analysis shows that the change is due, in part, to the loss of nitrogen. Fertilizers are applied to the land to increase the yield.

The problem will become clearer if we take another view. There was a time when fewer people lived in cities, and when this depletion of the soil was largely restored by the refuse from farm animals and even from man himself, from which it follows that the greater portion of the nitrogen removed as food for animals was returned to the soil in some other form available for plant growth.

We may next consider the complications that arise in dealing with such aggregates of population as our large cities. Sustenance must still be drawn from the soil, and since nitrogenous waste is no longer returned to the land it is clear that the latter is continually being depleted. A single example will illustrate the point. The sewage of the city of London has an estimated annual value of $100,000,000 as fertilizer, and that of any other city would represent an amount corresponding to its population. These drains, of course, must in some way be accounted for if the soil is to continue to produce. What, now, has science done to relieve the situation?

When chemical analyses of soils and crops had clearly defined the problem and had told the story of nitrogen, a search was made for some material that could supply the deficit. First, natural guano, as it is called, deposits consisting largely of the dried excrements of birds, and found in such arid districts as Peru, was obtained in as large quantities as possible. But material of this kind was limited in amount and is now practically exhausted.

Next, the chemist saw that the waste liquors of the gas works contained combined nitrogen that could serve as plant food, and we are now using in the United States $20,000,000 worth of ammonium sulphate as fertilizer per year. This, again, is limited because in this country about 80 per cent. of the coke is made in the wasteful "beehive" oven in which the vapors are simply burned on the spot. The ammonium sulphate derivable from those vapors in 1911 could have been sold for $24,000,000, to say nothing of the other compounds present. But gas plants can not be operated economically for the ammonium sulphate alone, and our coal beds are not inexhaustible, which shows that some other nitrogen supply must be found.

The third source of plant nitrogen is the Chile saltpeter bed, from which millions of tons of sodium nitrate have been taken as fertilizer to different parts of the world. This supply, also, is limited. Indeed, conservative estimates indicate that the deposits will be exhausted within a relatively short time, which means that man must solve the nitrogen problem in some other way, or he must eventually starve. The necessity for research in this field has been urged for many years, and it is now in order to ask what chemistry has done to relieve the situation.

It has already been stated that nitrogen

does not readily combine with other elements, and that animals and plants, with very few exceptions, can not use free nitrogen as food. But the free form is plentiful, since it makes up about four fifths of the atmosphere, while the greater portion of the remainder is oxygen. The specific problem, then, is to cause those two gases to unite, or to find some other way of "fixing" the nitrogen. This has been accomplished, and while the history of the commercial process now in use is full of interest, it must be passed here with mere mention. It should be noted in passing that Cavendish, an English chemist, showed as early as 1785 that nitrogen and oxygen could be made to unite under the influence of the electric spark, and that the product would react with water to give nitric acid. At that day, however, electricity was regarded as a mere toy, and no one dreamed of the possibilities locked up in that interesting though, to the average person, seemingly useless, laboratory experiment.

In 1898, Sir Wm. Crookes aroused interest in this problem again by calling attention to the future exhaustion of the Chile saltpeter beds, and urged a study of methods for fixation of nitrogen. In 1902, Bradley and Lovejoy, two American chemists, published an account of the commercial application of the Cavendish experiment mentioned above, while to-day the manufacture of nitric acid by that process in Norway is a business in which more than $30,000,000 is invested. Immense sums have been spent in its development in Germany and elsewhere.

At present, the manufacture of calcium carbide, so largely used in the production of acetylene for lighting and heating purposes, offers an important method for fixing nitrogen. The manufacture of the carbide was begun in this country several years ago and is now one of the leading industries of Niagara Falls. Frank and Caro, German chemists, found that the carbide could be made to combine with nitrogen in such a way as to produce a valuable fertilizer. The nitrogen it contains can readily be converted into ammonia, and from the latter nitric acid can be prepared. As a matter of fact the Germans are now producing 600,000 tons of the carbide annually in order to supply, through the reactions indicated, the nitric acid required to make explosives for the war.

In this brief and superficial fashion, I have tried to make it clear that the preparedness which the nations demand is twofold—agricultural as well as military—and that, in essence, both are largely chemical. Cheap fertilizer must be furnished in times of peace, and nitric acid and other materials for explosives in times of war. So much for the formulation of the demand. The real problem is to furnish the means by which this program can be successfully carried through.

So far as the chemical part of the program is concerned, two specific requirements must be met. First, there must be adequate training in the fundamentals of chemistry, and second, there must be opportunity for chemical research. The first is conceded by everybody, but many highly intelligent educated people do not understand research, and therefore call it theoretical and impractical. The cry is for applied science, for something practical. They fail to recognize the fact that there can be no applied science until there is science to apply. It is not strange that Huxley, with his extraordinary precision of thought and remarkable command of language, long ago pointed out that what people call applied science is nothing more than the application of the methods of pure science to particular classes of problems. Some one must patiently and laboriously determine the facts and formulate the principles before there can be any commercial

application of them; and, whether we recognize it or not, the world is waiting on the research worker.

If time were available it would be easy to show that practically all the great commercial successes rest upon principles formulated by research workers who, in many cases, labored solely for the love of truth, without any expectation that their work would immediately benefit mankind. But no one can tell at what instant some such observation may become of immense importance. I beg your indulgence to call attention to a few cases. Was Röntgen thinking of the extraction of bullets, the reduction of dislocated limbs or the setting of broken bones when he discovered the X-rays? By no means. Or Helmholtz, did he have in mind the prevention and cure of eye diseases when he worked out the principle of the ophthalmoscope? Not at all. Was Cavendish, to whom I have already referred, thinking of providing food and war munitions for the future when, 132 years ago, he read before the Royal Society his paper on the fixation of nitrogen? I think not. No one will doubt the great practical value to the human race of Pasteur's researches, but it is proper to point out here that he began by the study of the asymmetry of crystals, and that he became a bacteriologist through his attempts to disprove the doctrine of spontaneous generation. Scores of cases could be cited to illustrate the point, but the lesson is, learn the facts, and the applications will be forthcoming.

The expenditure of public money for the erection of the splendid building we are assembled to dedicate is an expression of continued confidence in the leaders in charge of our educational interests, and a pledge that the necessary equipment for the future shall be provided.

It is a pleasure to me to come here to-day and have a part in the dedication, not merely because of my interest in the educational welfare of our state, as a whole, but more particularly because of the opportunity it gives to emphasize the claim of science in general and chemistry particularly in connection with the problems now confronting the world. Interest in the study of chemistry has been steadily increasing for many years, but its importance has been emphasized by the war in a way that could not have been done otherwise. The University of Oklahoma is to be most heartily congratulated on having completed at this time a laboratory so carefully planned and so well equipped, as well as upon the work of its department of chemistry in the past. With the extra space and facilities offered by the new building, both the university and the state may confidently look forward to greater things in the future.

L. Chas. Raiford

Oklahoma Agricultural and Mechanical College

SCIENTIFIC EVENTS

ENGLISH VITAL STATISTICS

The annual report of the registrar-general on births, deaths and marriages in England and Wales for 1915, as summarized in the London *Times*, is remarkable for the number of previous "records" which are broken. Thus the marriage rate was the highest on record; the birth rate the lowest on record; the death rate from typhoid fever was the lowest on record; that from influenza the highest since 1900; and that from measles the highest since 1896. Again, the age rates of bachelors marrying spinsters and spinsters marrying bachelors were both the highest on record. Finally, the increase of boy babies over girl babies from July, 1915, to June, 1916, was the highest on record for 50 years. The estimated infant mortality rate for 1916 is the lowest on record.

The marriage rate was 19.5 per 1,000, being 3.6 above the rate in 1914. The provisional figures for 1916, however, indicate that what has been described as the "boom" in marri-

ages is passing; they suggest a return to the average experience in 1905–14. The birth-rate was 22 per 1,000. This is 3.5 below the average for the preceding ten years and 1.8 below the rate in 1914. The rate in England and Wales, however, compared "very favorably" with the experience of other belligerent countries. The provisional rate for 1916 is lower still—21.6 per 1,000.

The infant mortality during the year was 110 per 1,000 births. This is five per 1,000 above the rate in 1914, but is below the average of the years 1905–14. The provisional infant mortality rate for 1916 shows a fall to 91 per 1,000, the lowest on record. The civilian death-rate was 15.7 per 1,000, which is 1.2 per 1,000 above the average for the previous 10 years. Various factors, however, affect this figure, including the withdrawal of young men from civilian life. Most of the principal causes of death show increased mortality, but scarlet fever, typhoid fever and diarrhœal diseases are exceptions to this rule. The disease, cerebro-spinal fever, "spotted fever," showed an abnormally high death-rate. There was a remarkable decrease in male suicides. The position with regard to tuberculosis remained serious. There was a marked increase among males and a slight increase among females. These rates refer only to the civil population and are swollen by the fact that healthy males have been taken away from civil life in great numbers.

There were 360,885 marriages, an extraordinary number. The average age of bachelors marrying spinsters was 27.33 and of spinsters marrying bachelors 25.47, these being, as stated above, the highest recorded in each case. The number of births recorded was 814,614, of which 36,245 were illegitimate. Males numbered 415,205, females 399,409, the ratio being 1,040 to 1,000. This ratio for the whole year does not represent the true situation as regards "war babies." The March quarter, for example, which was unaffected by the war, showed a ratio of 1,032 males to 1,000 females. The December quarter, on the other hand, showed a ratio of 1,044 males to 1,000 females. For 1916 the ratios are known to be: March quarter, 1,050 males to 1,000 females; June quarter, 1,051; September, 1,045; and December, 1,050.

For the year from July 1, 1915, to June 30, 1916, that is for the first complete year during which the births registered have been fully affected by war conditions, the ratio is 1,047 males to 1,000 females. This figure is considerably—so far as males are concerned—above any recorded during the preceding 50 years and approximates to the European rate which has for many years been in excess of our own. A rise in mortality among the aged of both sexes has occurred. It is a feature which has appeared in the statistics of other belligerent countries and may be a reflex of the unusual stress and anxiety of the times.

THE COMMITTEE ON COAL PRODUCTION OF THE COUNCIL OF NATIONAL DEFENSE

The Council of National Defense has appointed Mr. Francis S. Peabody, chairman of and with authority to appoint a committee on coal production, representative of the coal-producing districts throughout the United States. It is the intention that the members of this committee shall act as chairmen of subcommittees to be appointed by them in their respective districts.

The committee convened in Washington on May 9, at which time, in addition to the members of the committee, there were present Secretary of the Interior Franklin K. Lane, Mr. W. S. Gifford, director of the Council of National Defense, and Mr. Bernard M. Baruch, chairman of the committee on raw materials, minerals and metals, of the advisory board of the Council of National Defense, from which an outline of the proposed scope of the committee's work was received.

In approving the appointment of this committee and laying before it the work that it was expected to do, Secretary Lane referred to the cooperative spirit already shown by the business men of the country in this mobilization of the resources of the United States.

> It would surprise the nations of Europe to know how intense is the spirit of loyalty on the part of our business men and capitalists. . . . You are at the very root and foundation of the great industry

—the war industry—that presents itself on the other side of the water. . . . Now, there are two ways of dealing with a problem of this kind. One way is by the hearty cooperation of the men already engaged in the industry. The other way is by compulsion. My experience in the Interstate Commerce Commission led me to believe that the larger men in the railroad industry had quite as much vision as I had, and if I could show them the importance of an occasion they would try to meet it. So, instead of resorting to compulsion, instead of taking over mines and great operating plants we are endeavoring to put you men at your best. This war is a challenge to us.

The chairman of the committee writes:

Notwithstanding the increased production of coal from practically every district, the increasing requirements to meet the needs of all classes of industry, as well as for the comfort and welfare of the people and the transportation of troops, munitions, food and other products, together with the supplying of our allies, and for our national protection—all these demands are liable to surpass the capacity of our mines unless the full cooperation of the mining, transporting and distributing agents of this country is secured. This emergency requires not only the development of the highest efficiency, especially on account of a diminished supply of labor used in the production of coal, but also in more comprehensive methods of cooperation by the coal producers with the transporting and distributing agencies, so that not only a full production will be secured, but also that this production finds its way over our railroads into those centers where the most urgent need exists. If the demand for this product continues to increase it may be necessary that active steps be taken to so far as possible confine the distribution and use of it to those activities which are more nearly vital to the welfare and protection of the nation. That this may not effect an unnecessary hardship upon the domestic welfare of our people it is necessary to promote the closest cooperation, and because of the duty laid upon us to promote this welfare we urge upon you that you cooperate with this committee in its efforts to promote the largest production, the most equitable distribution and the highest use to produce the best economic results. No doubt an emergency exists, but it is the belief of this committee that with your hearty support and the assistance of the public in conserving supply, sufficient fuel can be had to meet public necessity.

FOOD EXHIBITS AT THE AMERICAN MUSEUM OF NATURAL HISTORY

MANY foods, hitherto not eaten by the people of the United States, or which have only a limited vogue, are shown at the Food Values and Economies Exhibition opened on May 23 in the American Museum of Natural History.

An especially interesting feature of the exhibition is the division devoted to unutilized seashore foods, such as filet of shark, gray fish, mussels, skate, many kinds of edible seaweeds and periwinkles. The history and usefulness of the king of American cereals—corn—is graphically demonstrated. There are numerous products of corn and also cornmeal dishes and preparations.

The values by calories of portions in the popular restaurants are visualized and there are specimen meals suitable for serving in the home. How the population fares in lands beyond the sea will be shown by samples of war bread and of the rations prescribed by European food dictators. The housewife may also obtain from this exhibition many practical suggestions as to how to stop the leaks and to promote table economy. Several hotels of the city are to exhibit new dishes specially adapted for the conditions of the present day and from them many helpful hints may be obtained by the general public.

The exhibition will be open for about one month. It was introduced by a special meeting devoted to conservation for war, held in the auditorium of the museum on Wednesday. According to the program the president of the institution, Dr. Henry Fairfield Osborn, presided and addresses were to be delivered by Mr. George W. Perkins, chairman of the Mayor's Food Commission; Dr. Graham Lusk, professor of physiology, Medical College of Cornell University; Dr. Hermann N. Biggs, New York State commissioner of health; and Dr. Walter B. James, president, New York Academy of Medicine.

SCIENTIFIC NOTES AND NEWS

DR. CHARLES R. CROSS, Thayer professor of physics at the Massachusetts Institute of Technology, will become professor emeritus at the

end of the present year. Dr. Cross has been professor of physics at the institute since 1875.

AT a testimonial dinner given by the Philadelphia County Medical Society to Dr. James Tyson on his retirement after fifty-four years of practise on May 11, Dr. Hobart A. Hare was toastmaster and addresses were made by the following speakers: Dr. Henry D. Jump, president of the Philadelphia County Medical Society; Dr. Abraham Jacobi; Dr. William H. Welch; Dr. James W. Holland, and Dr. Edward Martin.

DR. T. BRAILSFORD ROBERTSON, professor of biochemistry and pharmacology in the University of California, has donated to the regents of the University of California his patents for the growth-controlling substance tethelin which he has succeeded in isolating from the anterior lobe of the pituitary body and which has been employed to accelerate repair in slowly healing wounds. The proceeds which may accrue from the sale or lease of these patents are to constitute a fund which will be entitled "The University of California Foundation for International Medical Research" and which will be expended in the furtherance of medical research, preferably in the physiology, chemistry and pathology of growth.

THE Société de Géographie has awarded its highest prize, the Conrad Malte-Brun Gold Medal to Dr. John H. Finley, president of the University of the State of New York, in recognition of "the exceptional interest and high merit of his volume, 'The French in the Heart of America.'" The Commission de Géographie of Quebec, with the approval of the Minister of Lands and Forests, has named a new township in Gaspé, P. Q., in honor of Dr. John M. Clarke, state geologist of New York in recognition of his scientific writings on Gaspé and especially of his book "The Heart of Gaspé."

PROFESSOR WM. BULLOCK CLARK, of the Johns Hopkins University, has been appointed by the governor of Maryland a member of the State Defense Council.

THE executive committee of the Entomological Society of America has commemorated the appearance of the fourth and final volume of the Carnegie mosquito monograph by electing Frederick Knab a fellow of the society.

THE Institute of Chemistry, London, has presented a silver bowl to Mr. R. B. Pilcher, registrar and secretary, in appreciation of his twenty-five years' service.

A COMMITTEE on research to cooperate with the National Research Council has been appointed at Washington University, consisting of members of the corporation, St. Louis alumni and faculty as follows: B. M. Duggar (chairman), J. Erlanger, E. Flad, W. W. Horner, A. S. Langsdorf, E. Mallinckrodt, R. McCulloch, L. McMaster, G. T. Moore, E. L. Opie, L. Pyle, P. A. Shaffer and J. L. Van Ornum.

A RESEARCH committee has been appointed at Iowa State College at the suggestion of the National Research Council. The committee is representative of the various interests of the college and is made up as follows: P. E. Brown, professor of soil bacteriology, chairman, J. M. Evvard, associate professor of animal husbandry, L. H. Pammel, professor of botany, L. B. Spinney, professor of physics, Helen Monsch, associate professor of domestic science, Chas. Murray, associate professor of veterinary pathology and bacteriology.

A FIRM of geologists has been organized in Tulsa, Oklahoma, for consulting work, consisting of Messrs. J. B. Newby, R. E. Garrett, J. R. Crabtree and A. P. Wright.

CHARLES FULLER BAKER, professor of agronomy in the college of agriculture of the University of the Philippines, has been given a year's leave of absence, to accept under temporary appointment, the post of assistant director of the Botanical Gardens at Singapore, in charge of experimental work in tropical agronomy.

B. R. LEACH, of the Bureau of Entomology, who has been in Washington preparing manuscript and notes on the results of his investigations of the woolly apple aphis, has returned to his permanent headquarters at Winchester, Va., to resume his field duties in connection with apple insect investigations.

Frank R. Cole, scientific assistant in the Bureau of Entomology, formerly located at Washington, D. C., has been detailed to Hood River, Ore., to investigate insects injurious to strawberries and other truck crops in cooperation with the Oregon Agricultural Experiment Station at Corvallis.

Dr. L. H. Pennington, of the college of forestry of Syracuse University, has been put in charge of the white-pine blister rust survey for the State of Michigan, as the representative of the Bureau of Plant Industry. His headquarters, when not in the field, are at the department of botany, Michigan Agricultural College, East Lansing, Mich.

Thomas Clachar Brown has resigned his position as associate professor of geology at Bryn Mawr College and has taken up work in agriculture. He may be addressed at Laurel Bank Farm, Fitchburg, Mass.

Professor Edward Orton, Jr., for many years dean of the college of engineering of Ohio State University, and at present research professor in ceramic engineering, has obtained indefinite leave of absence from the university. He has been commissioned as a major in the Quartermasters Corps, Officers Reserve Corps, United States Army, and has been ordered to report for duty to Fort Sam Houston, Texas.

Dr. Bertram G. Smith, associate professor of zoology at the Michigan State Normal College, Ypsilanti, has obtained leave of absence to enlist in the Reserve Officers' Training Corps, and is now stationed at Fort Sheridan, Ill. Mr. A. G. Papworth, of the University of Michigan, is taking charge of Dr. Smith's work at the Normal College.

At its last meeting on May 9, 1917, the Rumford Committee of the American Academy of Arts and Sciences made the following appropriations:

To Professor Frederic Palmer, Jr., in aid of his research on light of very short wave-lengths (in addition to former appropriations), $100.

To Mr. David L. Webster for the salary of an assistant in connection with his research on the intensity of lines in X-ray spectra, $100.

To Professor B. J. Spence in aid of his research upon a new Color Identity Pyrometer, $75.

To Professor B. J. Spence in aid of his research upon a new and more sensitive form of radiometer, $150.

To Professor R. C. Gibbs in aid of his investigations on the absorption of organic and other solutions for ultra-violet, visible and infra-red rays, $500.

To Professor W. M. Baldwin in aid of his research on the character of chemical substances necessary to sensitize animal tissues to the influence of X-rays, $125.

The North Carolina Academy of Science at its recent meeting elected as officers for the ensuing year:

President, Professor W. A. Withers, Agricultural and Engineering College, West Raleigh.

Vice-president, Dr. J. H. Pratt, State Geologist, Chapel Hill.

Secretary-Treasurer (tenth year), Professor E. W. Gudger, State Normal College, Greensboro.

Additional Members of the Executive Committee, Mr. Bert Cunningham, High School, Durham; Mr. H. R. Totten, University of North Carolina, Chapel Hill; Professor H. C. Beardslee, Asheville School, Asheville.

Dr. Julius Stieglitz, chairman of the department of chemistry of the University of Chicago, lectured before the Nebraska Section of the American Chemical Society on the morning of April 28 and before the Nebraska Chapter of Sigma Xi on same evening. The subject of his morning lecture was "The Electron Theory of Positive and Negative Valences" and of the evening lecture "Combustion or the Electrical Theory of Oxidation."

Dr. J. McKeen Cattell gave an address on May 19 before the Twentieth Century Club at Boston on "Free speech in the university."

The annual public botanical address, under the auspices of the Botanical Seminar of Michigan Agricultural College, was delivered on May 15, by Dr. L. H. Pennington, of Syracuse University, his topic being "White-pine blister rust."

By the death of Samuel Alexander at his home in Detroit on May 15 is lost one of the old time amateur botanists, that is, a man

who worked in botany because of his ardent love of plants. Mr. Alexander was nearly eighty years old at the time of his death, but still kept up his studies in spite of illness that limited his active collecting for the past three years. For the last ten years his chief studies were on the perennial sunflowers, of which he found great numbers of forms and of which he hoped to be able to publish a monograph. He was at one time city forester for Detroit and furthered the planting and care of trees in that city at a time when there were but few voices advocating such things. He entered the Michigan Agricultural College in the early spring of 1861 but left in a few days as the first volunteer from that institution for the war.

WE learn from *Nature* that Major A. C. B. Geddes, who had begun work in natural science has been killed in the war at the age of twenty-five years. He was the eldest son of Professor Patrick Geddes.

THE death is announced of S. Tolver Preston, known for his writings on cosmical physics.

M. HENRI BAZIN, distinguished for his work on hydraulics, has died at the age of eighty-eight years.

THE sixteenth biennial Dutch Congress of Natural and Medical Sciences was held at The Hague on April 12 and following days. We learn from *Nature* that in connection with this, the geography section had organized an interesting historical exhibition, mainly of the work of Mercator and the Dutch cartographers of the seventeenth century. The chief general lecture was delivered by Professor H. A. Lorentz, of Leyden, on "Einstein's Gravitational Theory and Fundamental Ideas in Physics." From a discussion, in one of the sections, on chemical industry in Holland, it appears that the manufacture of aniline and other intermediate materials for the dye industry was started in 1916.

THE next meeting of the American Association of Pathologists and Bacteriologists will be held at Minneapolis on March 29 and 30, 1918.

THE twelfth annual meeting of the American Association of Museums was held in New York City from May 21 to 23, inclusive. The association consists of directors and curators of leading American institutions. The sessions on Monday and Wednesday were at the American Museum of Natural History. Those on Tuesday were at the Metropolitan Museum of Art and on Tuesday evening there was an inspection of the New York Aquarium and an informal smoker. On Thursday the delegates visited the Central Museum of the Brooklyn Institute of Arts and Sciences and the Children's Museum of the Brooklyn Institute. On Friday they inspected the New York Botanical Gardens. Trips were also arranged to the Public Museum of the Staten Island Association of Arts and Sciences and to the Newark Museum. An especially interesting phase of the sessions was the report of the committee on training for museum workers, which was devoted to finding ways and means of increasing the practical usefulness of museums.

The Electrical World states that as a result of the present war conditions the Manitoba branch of the American Society of Civil Engineers has organized a scientific and industrial research committee to organize and develop the natural resources in industry and science. At present this committee is listing all available research laboratories in its jurisdiction, also all men engaged in scientific and engineering pursuits and the qualifications of each man in his particular line of research or engineering. After organization is completed a study will be made of the requirements of the Province of Manitoba as regards manufactured articles, and more especially imports, with a view to supply all local demand for such material and, if possible, to provide for export, if it can be economically accomplished.

THE trustees of Purdue University have approved the organization of an engineering experiment station. This station will be employed for the supervision of engineering research. Arrangements have also been made for the extension and equipment of a high-

voltage laboratory, in which pressures as high as 500 kv. can be obtained.

UNIVERSITY AND EDUCATIONAL NEWS

Steps have been taken to insure the erection of a new building for the Indiana University School of Medicine on a site near the Robert W. Long Hospital, Indianapolis.

Professor Robert M. Yerkes, of Harvard University, has been appointed head of the department of psychology at the University of Minnesota.

At the Johns Hopkins University, Professor Edward W. Berry, associate professor of paleontology, has been advanced to be professor of paleontology, and Associate J. T. Singewald, Jr., to be associate professor of economic geology.

At the Massachusetts Institute of Technology, Dr. Charles L. Norton has been appointed professor of industrial physics. Promotions from instructor to assistant professor have been made as follows: Mathematics, Joseph Lipka and Frank B. Hitchcock; physics, Herbert P. Holnagel; drawing, Arthur L. Goodrich.

Dr. H. H. Newman, dean of the college of science of the University of Chicago (medical and premedical students), has been promoted from an associate professorship in zoology to a professorship in that department.

In the botanical department of the Michigan Agricultural College Dr. G. H. Coons has been promoted to associate professor, and Dr. E. F. Woodcock to assistant professor. Beginning with July 1, Mr. Ezra Levin, at present instructor in botany at the Kalamazoo High School, takes up his work as extension agent in plant diseases, for half his time, and assistant pathologist in the Experiment Station for the other half.

Dr. Pierre Marie has been appointed to the chair of clinical neurology in the University of Paris in succession to the late Professor Dejerine.

Fräulein A. M. Curtius has been appointed lecturer in French at Leipzig. She is said to be the first woman on the staff of a German university.

DISCUSSION AND CORRESPONDENCE

SURFACE TENSION, CAPILLARITY AND PETROLEUM POOLS

While surface tension and capillarity[1] are being discussed, the writer would like to raise the question of whether or not the material composing the tube makes any difference in the height to which the liquid rises.

It is surprising that it is not possible to settle this apparently elementary question at once by reference to any one of a score of good treatises on physics; physics is an old science, the subject of intermolecular attraction is fundamental, capillarity is discussed at length and the deductions carry conviction born of impressive formulæ. As a matter of fact, statements bearing on the point in question seem inharmonious and many of them lack clearness. One of the most convincing that the writer has seen is that of Bigelow and Hunter,[2] who say: "We have demonstrated that capillary ascension of water (and benzene) is different in tubes of different substances," and they base the assertion on experimental evidence.

This declaration accords with the writer's[3] concepts concerning capillarity. Since he is not a physicist, these concepts should come from the conclusion of physicists concerning the point or at least from well-known and unquestioned principles of physics, but as a matter of fact they are based partly upon such conclusions and principles, partly upon several years of cogitation, and partly upon the

[1] Patrick, W. A., Ostwald's "Handbook of Colloidal Chemistry," Science, N. S., Vol. XLV., No. 1,143, pp. 750–751, November 24, 1916. Kimball, Arthur L., "Negative Surface Tension," Science, N. S., Vol. XLV., No. 1,152, p. 75, Jan. 26, 1917. Becker, Geo. F., "Propulsion by Surface Tension," Science, N. S., Vol. XLV., No. 1,153, p. 115, Feb. 2, 1917.

[2] Bigelow, S. L., and Hunter, F. W., "The Function of the Walls in Capillary Phenomena," *Jour. Phys. Chem.*, Vol. 15, p. 380, 1911.

[3] Shaw, E. W., "The Rôle and Fate of Connate Water in Oil and Gas Sands" (discussion), *Am. Inst. Min. Eng. Trans.*, Vol. 51, p. 601, 1916.

results of some experiments which may seem more significant to the writer than they would to a physicist. Up to the time Bigelow and Hunter's paper was published, at least, the literature did not seem to cover the point at all satisfactorily, yet many statements and implications seem to be clear. Ramsay and Shield's classic determinations of surface tension based upon capillary rise may be cited as an example. If capillary rise is affected by the nature of the tube, their results would apparently be invalidated.

Do not three substances ordinarily play parts in capillarity, and does not the result depend on the identity of each of the substances? If water, air and glass are the substances, the water heaps up against the glass, and if the tube is of hair-like diameter there is a rise of water. Is not this due to the fact that where water, air and glass come together molecules of water are drawn toward the glass much more than toward molecules of air or other molecules of water?

The mechanics of this process seem simple, whereas it is difficult to conceive how the raising of the liquid can be a product of its surface tension alone,[4] even though the walls of the tube above the liquid have a contractile coating of adsorbed liquid or a membranous extension of the liquid in the tube.

The writer is particularly interested in the part that capillarity or differences in intermolecular attractions may play in oil and gas accumulation. In the vicinity of oil and gas pools which occupy the pores of rocks in the earth, water with various quantities of salt in solution, oil of one or more kinds, natural gas and perhaps air are in contact with each other and with various minerals. Oil and gas are found in relatively large-pored rocks, in pools which show some similarity in shape and the pressure upon them is usually several hundred pounds to the square inch. The pressure on some pools is greater than that which would be exerted by a column of water extending to the surface. May not these features be explained in considerable part by differences in intermolecular attractions?

E. W. Shaw[5]

[4] Washburne, C. W., "The Capillary Concentration of Gas and Oil," *Am. Inst. Min. Eng. Trans.*, Vol. 50, p. 830, 1915.

[5] Published by permission of the director, U. S. Geological Survey.

SYNCHRONOUS RHYTHMIC MOVEMENTS OF FALL WEB-WORM LARVÆ

Recent discussion in Science of synchronous actions of certain animals, notably flashing of fireflies, brings to mind a habit of the larvæ of the fall web-worm (*Hyphantria cunea*), which seems to be of the same nature. Whether it has been noted in the literature or not I am unable to say; probably it has, as it is of common occurrence. In any event a short account of the habit may not be out of place in this connection.

Fall web-worm larvæ, scattered over the outside of the web, may be seen, at intervals of from three to five minutes, to start a sharp rhythmic swaying from side to side, accomplished by raising the anterior half of the body to a semi-erect position, then moving it quickly, first to one side then to the other, through an angle of about ninety degrees. The movement is started by a few of the larvæ, but in a few seconds all the individuals in the colony will be moving in the same manner and in perfect unison. I do not have my notes at hand but, as I remember it, the movements were at the rate of about forty per minute and continued each time for from forty-five seconds to more than a minute. Even more suddenly than they start, the movements cease.

What the cause is for this strange habit is a puzzle. It seems to have nothing to do with spinning the web. Artificial stimuli failed to start them before the end of the resting interval although various means were tried. These included sounds, both musical and otherwise, made with various instruments, smoke and strong chemical odors, jarring and several other devices which suggested themselves at the time. Equally futile were attempts to stop the movements.

There seemed to be no leader, the swaying starting one time in one part of the colony or even in several parts at once, and again in

some other part. Invariably, however, all would join in.

This habit was first observed by me several years ago, just how long I do not remember. It is associated with my earliest recollections of the insect. I have made more or less careful observation of it and taken notes several times, the first time in 1912. I do not think that I ever saw a colony that did not have the habit and I have had them in the laboratory every summer for several years. Observations of the habit may be made on colonies confined in the breeding cage or on those in the natural conditions. There seems to be no difference.

There is no doubt in my mind that this habit is an excellent example of synchronous rhythmic motion, not occasional or accidental, but habitual with the species. It may be well added to Mr. Craig's single, more or less doubtful, example, that of the chirping of crickets.

L. M. Peairs

Entomological Laboratory,
West Virginia University

THE POPULAR NAMES OF NORTH AMERICAN PLANTS

An article under this title in Science for February 2, by J. Adams, opens a question which has interested the present writer partly for the same reasons as there given, and he has passed through various stages of mental attitude toward it.

A notable fact is that common names when once established are apparently more stable than the scientific names. The names of birds furnish a good example of this, very few common names having been changed in the last fifteen years while a fourth or more of the scientific names have been changed, and some of them two or three times. However, the number of species of seed plants is about ten times as great as that of birds.

This very stability indicates difficulty in establishing common names where none exist. Names are a result of necessary "handles," and the greater part of those species which have not received them are not regarded frequently enough to establish names. The essential qualities of a name would seem to be significance and simplicity. The use of qualifying adjectives should be avoided as far as possible. The writer is not certain that a species must bear the same name in different regions, or that different species may not have the same one inasmuch as a name which is appropriate in one place may not be in another, and similar species often occupy similar places in different regions. The writer places much value on local lists, keys, etc., including a single state or natural area. This restricts the number of species involved and simplifies identification.

The surest way to acquaint the general public with the names of plants is through illustrations. Is it not possible to have a cooperative system by which different states would be responsible for certain portions and thus distribute the cost of production as widely as possible? This would eliminate the duplication now current from the publication of similar material in different places and permit the use of first-class illustrations of uniform quality, as well as help to unify the names.

O. A. Stevens

Agricultural College, N. D.

FAUNAL CONDITIONS IN SOUTH GEORGIA ISLANDS

During a recent visit to the islands of South Georgia (latitude 54° south) a very curious faunal condition was noted, and as this is, perhaps, of biological interest, it may be well to state briefly the facts of the case.

South Georgia lies in the sub-Antarctic region a few hundred miles to the east of Cape Horn. The season is open for about three months, but quite rigorous the remainder of the year. The principal vegetation is tussock grass, and this at one time supported many rabbits and perhaps a few other species of mammals. A few decades ago, the whaling industry was started with South Georgia as a base of operations. To-day there are nine whaling stations on the large island, and in a good season of three or four months, several thousand whales are handled. The carcasses are allowed to drift along the beach, as soon as the outer coating of blubber has been removed.

As a result of this, there are several miles of these huge decaying masses around the various stations.

Until about thirty years ago, there were no rats on the islands. At that time a sealing vessel allowed a few rats to go ashore, and the result to-day is appalling in its enormity.

The conditions have been ideal for these rats—with their nests in the tangled bunches of tussock and peat, and with a constant supply of meat in all stages of decomposition and cold storage close at hand!

There are literally millions of these rodents working away at the carcasses and swarming along the well-traveled trail which they have made on the mountain slopes. Even when the winter snows cover the place, operations in this rat haven are not stopped.

It was stated at one of the whaling stations that the rats have devastated the few small animals living on the island, and, indeed, are a menace to the health and safety of the place.

It would be interesting to know what characteristics the rat would develop after a few years of such a specialized habitat.

I. A. LUKE

SCIENTIFIC BOOKS

Les Sciences Biologiques Appliquées à l'Agriculture et la Lutte Contre les Ennemis des Plantes aux États-Unis. By DR. PAUL MARCHAL. Extrait des Annales des Épiphyties Tome Troisième. Paris, Librairie Lhomme. 1916. Pp. 30–390.

It does not seem like four years since Dr. Marchal visited this country and traveled from east to west and north to south, visiting the field laboratories of the Bureau of Entomology and educational institutions, yet actually that trip was taken in the summer of 1913. His book, under the title (translated) "Biological Sciences Applied to Agriculture and the Struggle against the Enemies of Plants in the United States," was received in this country in November last, its publication having been delayed by the war, and it is even now printed only in a very small edition. It is a large royal octavo volume covering nearly four hundred pages, abundantly illustrated. Marchal has a remarkable mind. It is little less than marvelous that in two months and a half he should have grasped the whole field in so perfect a way as to be able to write a book which is especially illuminating to us who are in the middle of things and who can not get the perspective which he reached after he returned to France and collected and classified his notes and impressions. The larger part of the book is devoted to the Bureau of Entomology, pages 52 to 198 being given to this service. The rest of the Department of Agriculture is considered in the following 30 pages, and 20 more are given to the experiment stations, the state entomologists, the Horticultural Commission of California, and the forestry services of the different states. Then follow 40 pages on universities and agricultural colleges, especial space being given to Cornell University and the universities of Illinois, California, Stanford and Harvard. He is enthusiastic over the Association of Economic Entomologists. The remaining 100 pages of the book are devoted to chapters on insect carriers of disease, the methods employed in the struggle against the enemies of crops (this chapter being divided into cultural methods, biological methods and technical methods), the laws concerning the protection of plants, including the insecticide law, and a conclusion. In this conclusion, after praising in an unstinted way the establishments of this country and the work which has been done, he especially points out that, far from narrowing itself in applications of science, the United States holds a place of the first rank in creative science. He thinks that France has much to learn from America, although it would be a mistake in his country to create an organization imitating in all respects the Department of Agriculture at Washington. He shows that the economic and cultural conditions are quite different on the two continents and that certain questions which have prime importance here have only a secondary interest in France. He is inclined to think that the United States Department of Agriculture is rather over organized, and thinks that the future will bring about a

simplification of its constituent elements. The main lesson that he learned by his journey is that France can no longer remain stationary in these matters and that it should make efforts to organize biology as applied to agriculture upon a large and solid basis, and he proceeds with practical suggestions in this direction. He praises the Federal Horticultural Board, the Federal Insecticide Board, and the Horticultural Commission of California, and thinks that all of these should be imitated in France. He especially points out the necessity for the introduction into France of such education as our young men get in applied biology in the agricultural colleges and universities like Cornell and Illinois. There is, he points out, in France at the present time no way of getting a scientific education in biological studies as applied to agriculture.

After pointing out some of the great examples of monetary saving in this country as the result of work in applied biology, he closes with the sentence, "These are great examples which it is well to recall, for they establish with the most complete evidence the fact that there is no other sure way than that of scientific organization of work to get full value from the national soil and to give back to agriculture the greatest possible part of the riches which are lost to it annually from pests."

L. O. Howard

CONCERNING THE HISTORY OF FINGER-PRINTS

Sir William J. Herschel published recently a brief pamphlet of 41 pages under the title "The Origin of Finger-Printing" (Oxford University Press, 1916). This is mainly an autobiographical sketch, giving in detail the story of how the author during the time of his useful service in India (1853–78) conceived the notion of finger-prints and elaborated this system, which was subsequently developed and placed on a truly scientific basis by Sir Francis Galton. We are indebted to Sir W. Herschel for his interesting document: it is always valuable when one who has played a prominent rôle in inaugurating a new movement presents us with a record of what he believes was his share in bringing about this innovation or invention. The inventor, however, will seldom be able to write impartially the history of his own invention; no one, in fact, whether statesman, artist, poet or scholar, while recording his own history, has the faculty (I should even say, the right) of clearly determining his own place in the long chain of historical development. This judgment must be left to the historian of the future. The principal purpose by which Sir W. Herschel was guided in writing his account is to demonstrate that he was the real "discoverer" of finger-prints in Bengal in 1858, entirely from his own resources, and to discredit all other claims to priority in this matter, especially those on the part of the Chinese. I regret that the author has failed to take notice of the "History of the Finger-Print System" published by me in the Smithsonian Report for 1912 (pp. 631–652, Washington, 1913). Not only are Sir W. Herschel's great merits and his share in the history of the invention, if invention it may be called, duly acknowledged and objectively expounded there, but he would also have found there all the available evidence in favor of the Chinese, Japanese and Tibetans, all of whom applied ages ago with full consciousness the system of finger-prints for the purpose of identifying individuals. The few modern traces of evidence known to Sir W. Herschel are treated by him slightly, and he wonders that "a system so practically useful as this could have been known in the great lands of the East for generations past, without arresting the notice of western statesmen, merchants, travelers and students." The Mohammedan authors who visited China did not fail to describe this system. Rashid-eddin, the famous Persian historian, who wrote in 1303, reports as follows:

When matters have passed the six boards of the Chinese, they are remitted to the Council of State, where they are discussed, and the decision is issued after being verified by the *khat angusht* or "finger-signature" of all who have a right to a voice in

the council. This "finger-signature" indicates that the act, to which it is attached in attestation, has been discussed and definitively approved by those whose mark has thus been put upon it. It is usual in Cathay [China], when any contract is entered into, for the outline of the fingers of the parties to be traced upon the document. For experience shows that no two individuals have fingers precisely alike. The hand of the contracting party is set upon the back of the paper containing the deed, and lines are then traced round his fingers up to the knuckles, in order that if ever one of them should deny his obligation this tracing may be compared with his fingers and he may thus be convicted.[1]

Professor Henri Cordier of Paris, the editor of Yule's famous work, adds to this passage a footnote relative to the history of finger-prints, and commenting on the claim of Sir W. Herschel, tersely remarks:

Sir W. Herschel was entirely wrong; Mr. Faulds protested against the claim of Sir W. Herschel, and finally a Japanese gentlemen, Kumagusu Minakata, proved the case for the Japanese and the Chinese. None of these writers quoted the passage of Rashid-eddin which is a peremptory proof of the antiquity of the use of finger-prints by the Chinese.

Indeed it is, and the observation that no two individuals have finger-marks precisely alike is thoroughly Galtonian. There is the earlier testimony of the Arabic merchant Soleiman, who wrote in A.D. 851, and who states that in China creditor's bills were marked by the debtor with his middle finger and index united (see my History, p. 643). But we have more. E. Chavannes, in reviewing my article in the *T'oung Pao* (1913, p. 490), has pointed out three contracts of the T'ang period, dated A.D. 782 and 786 and discovered in Turkestan (two by Sir Aurel Stein), which were provided with the finger-marks of both parties, and contain at the end the typical formula:

The two parties have found this just and clear, and have affixed the impressions of their fingers as a distinctive mark.[2]

A clay seal for which no later date than the third century B.C. can be assumed, and which bears on its reverse a very deeply and clearly cut impression of the owner's thumb-mark, has been brought back by me from China, and is illustrated and described in the above paper. I have also shown how the system was developed in ancient China from magical beliefs in the power of bodily parts, the individual, as it were, sacrificing his finger in good faith of his promises; in its origin, the finger-print had a magical and ritualistic character.

Sir W. Herschel states that he fails to see the definite force of the word "identification" in the Chinese finger-print system. In his opinion, there must be two impressions at least, that will bear comparison, to constitute "identification." He thinks, of course, one-sidedly of the detection of criminals to which the process has been applied by us, but never in the East (for what reason, I have stated elsewhere). Most certainly, the idea underlying Chinese finger-prints was principally that of identification, as expressly stated by Rashid-eddin and all Chinese informants. If a doubt or litigation arose, all that was necessary was to repeat the finger impression of the contractor who had formerly signed the deed.

B. LAUFER

FIELD MUSEUM,
CHICAGO, ILL.

[1] See H. Yule, "Cathay," new ed., Vol. III., p. 123, London, 1914, Hakluyt Society.

[2] See A. Stein, "Ancient Khotan," Vol. I., pp. 525–529, Oxford, 1907, where the three documents are published and translated by Chavannes.

SPECIAL ARTICLES

ON THE COLLOID CHEMISTRY OF FEHLING'S TEST

I

As familiarly known, when Fehling's solution is treated with a reducing substance, it is generally expected that a bright red precipitate will be obtained. Frequently, however, an orange or yellow precipitate is obtained and in certain instances nothing but a yellowish-green or bluish-green discoloration results. The attempts to account for these differences are, for the most part, chemical in nature; it is held that the red reaction represents a precipitate of cuprous oxide, the orange or yellow ones more doubtful suboxides or hydrated forms of the oxide, while the character of the greenish discolorations is left doubtful. It is often be-

lieved that these latter represent but questionable evidence for the presence of any true reducing substances, or if conceded to be positive evidence for such, it is held that the reducing substances can not be present in great amounts.

An investigation of this series of changes from a colloid-chemical point of view reveals the fact that these color changes are coincident, not with differences in the nature of the reduction products, but only with differences in the size attained by the particles of reduced substance. If the copper oxide particles are brought down in very fine (subcolloid or colloid) form, the greenish discolorations are produced; as the copper oxide particles grow in size they become yellow, then orange, and when very coarse they are red. The series shows, in other words, what has been observed by different colloid-chemical workers: that one and the same material may, in the colloid state, show different colors, the color order following Wolfgang Ostwald's color law, according to which the most highly dispersed particles of a given substance are likely to be yellow, turning, as the size of the particles increases, to orange or red, and finally to violet, blue or black.

As to which of these possible colors will be obtained from a Fehling's solution undergoing reduction depends upon the conditions surrounding the reduction, the greenish discolorations being obtained whenever the conditions are such as will keep the cuprous oxide, as produced, in its finely divided state; while the red will result when opposite conditions obtain.

Three factors are chiefly concerned in the process:

1. Contrary to the generally accepted notion, the presence of too much reducing substance (as too much dextrose) is more likely to yield a greenish result than the presence of too little. This is because with much reducing substance the reduction starts from many points at once, but with exhaustion of the available copper salt the process comes to a halt before the cuprous oxide particles have attained any great size.

2. Irrespective of the amount of reducing substance present, the greenish discoloration will be obtained whenever materials are present in the reaction mixture which tend to stabilize the cuprous oxide in its finely divided form. Such materials are of the group of the lyophilic (hydrophilic) colloids and whenever present, either because added experimentally to reaction mixtures prepared in the laboratory or brought in with the mixtures being tested for reducing bodies (like diabetic urine) they incline to stabilize the cuprous oxide when this is still in a finely divided state.

3. With certain reducing substances (like dextrose) such "protective" hydrophilic colloids may be produced in the course of the reactions incident to the Fehling's test itself. In the action of the alkali of Fehling's solution upon dextrose, for example, there are produced, from a chemical point of view, not only the various degradation products which are responsible for the reduction of the copper salt, but, from a colloid point of view, many of these are colloid in nature and so tend to inhibit a precipitation of the cuprous oxide in coarse form.

Consideration of these various facts not only renders intelligible many of the excellent empiric instructions which different chemists have long found useful when Fehling's test for the qualitative or quantitative determination of various reducing bodies is employed, but they indicate also what schemes should be followed if it is desired to get the copper oxide precipitated in its coarse red form.

To allow adequate time for the growth of the cuprous oxide particles, it is better to make reductions at low temperatures than at higher ones. A Fehling's test carried out at room temperature by mixing the Fehling's solution with the suspected material and setting this aside for twenty-four hours is therefore more likely to yield a red precipitate than if the test is made by boiling the two together in the ordinary way.

Care should also be taken not to use excessive quantities of the material containing the reducing bodies. This not only avoids the possibility of using more reducing substance than there is available copper salt that may be

reduced, but it minimizes the possibilities of adding excessive quantities of protective colloids which might stabilize the cuprous oxide in its finely divided form. Finally, in doubtful cases, a dilution of the reaction mixture is always to be tried. By this method there is avoided not only excessive concentration of the reducing body itself, but through adequate dilution, both those protective colloids which may be added from without, or those which may be formed in the reaction mixture itself are likely to be diluted to a point where their effect in stabilizing the cuprous oxide in its finely divided form is largely lost.

II

While working on the reduction of Fehling's solution by formaldehyde, we encountered a series of reactions which, while largely familiar to the physical chemists since Bredig's classical studies on the inorganic ferments, are somewhat new in their sum total; and since the reactions are strikingly like those observed in biological material, we have used them to elucidate the nature of such biological reactions for our students.

Formaldehyde reduces a Fehling's solution not only to the ordinary cuprous oxide, but to the metallic copper. The copper comes down in colloid form, but as this happens, a second reaction ensues in which the metallic copper acts upon the formaldehyde and decomposes it with the liberation of hydrogen. The liberation of hydrogen continues for hours, until either all the formaldehyde has been decomposed or all the copper salt has been reduced.

We use this reaction as a biological analogue illustrating the formation of an enzyme (the reduced copper) from a series of simple "dead" materials (alkali, salts, carbohydrate). From another point of view we may say that the formaldehyde poisons or acts as a toxin upon the Fehling's solution. Against this the reaction mixture produces an antitoxin (the metallic copper).

The reaction may also be used to illustrate the action of different enzymatic poisons. Potassium cyanide, for example, when added to the Fehling's solution will not only prevent its reduction by the formaldehyde but, added after the reduction has been initiated, will inhibit or stop further reduction and liberation of hydrogen.

As emphasized by Hoppe-Seyler, the production of nascent hydrogen is held to be essential in the chemistry of respiration. But depending upon whether this production of hydrogen in a biological oxidation mixture occurs in the presence or in the absence of oxygen, totally different effects (as an oxidation in the one case or a reduction in the other) may be brought about. The same is true of the chemistry of a Fehling's solution when reduced by formaldehyde.

If a substance like methylene blue or phenolsulphonephthalein is added to the reaction mixture, these dyes are left untouched or are deoxidized, depending upon whether the reaction mixture is kept in a flat dish exposed to oxygen or in a tall tube from which oxygen is largely excluded. In other words, the first dye behaves just as in the classical experiments of Paul Ehrlich upon tissue oxidations; the phenolsulphonephthalein acts as in the experiments of E. C. Kendall. Phenolsulphonephthalein suffers reduction in the body whenever oxygen is absent while it is left untouched when this is not the case.

A detailed account of these experiments has been sent to the *Kolloid-Zeitschrift* for publication.

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March 13, 1917

THE OIL CONTENT OF COTTON SEED AN ACCURATE BASIS FOR COMMERCIAL STANDARDIZATION

As a result of four years' work by the author, three of which are shown in the table below, and based on more than 500 determinations in the cotton industry laboratory of the Georgia State College of Agriculture, it was found that the oil content of cotton seed is an inherent characteristic of the variety, and that the percentage of oil in any variety can be increased by selection with no corresponding loss of other desirable qualities. Al-

though there may be slight variations from year to year, depending upon the season, these environmental factors influence all varieties alike, and the seed of the varieties that were high in percentage of oil the first year have remained so during subsequent seasons. The seed of the same variety when grown on the sandy soil of the coastal plains produce uniformly less oil than when grown during the same season on the red clay soil of the Piedmont Plateau. This difference varies from 0.51 gallon to 2.3 gallons per ton of seed, depending upon the variety. In a general way the varieties with the highest proportion of meats to hulls produce the most oil; but there is no positive correlation between percentage of meats and the oil content, since the percentage of oil in the meats varies with the variety.

TABLE SHOWING AVERAGE RESULTS OBTAINED WITH AIR-DRY SEED OF TWENTY-ONE VARIETIES OF COTTON GROWN FOR THREE SUCCESSIVE YEARS ON THE COLLEGE DEMONSTRATION FIELD, AT ATHENS, GEORGIA

Name of Variety	Per Mol			Total G per T		t.1 in	t 6.1 Me
Rexall............	7.62	38.34	23.30	62.14	50.50	3.47	1,067
Hite's............	7.99	40.44	22.55	60.14	48.90	3.38	1,030
Perfection	7.15	38.91	22.38	59.68	48.10	3.50	1,037
Cook's...	7.01	41.17	21.94	58.50	47.40	3.34	1,013
Willet's Ideal..	7.46	41.43	21.78	58.08	47.00	3.33	1,016
Poulnot	7.63	41.16	21.38	57.01	45.70	3.39	1,052
Brown's No. 3.	7.66	42.18	21.24	56.64	45.60	3.31	1,018
Livesey's........	7.70	40.75	21.07	56.19	4[illegible].90	3.45	1,052
Texas Bur......	6.80	41.33	20.93	55.[illegible]	[illegible]4.70	3.42	1,038
Brown's No. 1.	7.93	41.85	20.89	55.70	44.40	3.37	1,057
College No. 1...	8.78	43.25	20.63	55.01	44.30	3.27	994
Hooper's	6.81	41.75	20.76	55.36	44.20	3.39	1,046
William's.......	7.51	41.44	20.75	55.34	44.10	3.42	1,061
	8.50	42.90	20.40	54.40	43.60	3.32	1,016
	8.20	42.90	20.37	54.32	43.30	3.32	1,032
Brown's No. 2.	7.79	43.32	20.24	53.98	43.10	3.30	1,019
Christopher.....	7.25	42.52	20.18	53.82	42.80	3.37	1,034
Bramblett's.....	6.60	42.56	20.11	53.62	42.50	3.38	1,047
Meadow's....	7.51	42.40	20.05	53.46	42.50	3.40	1,032
Caldwell's......	7.04	43.01	19.93	53.14	42.30	3.35	1,018
Lankford's......	7.94	46.38	18.88	50.34	40.10	3.14	969
Average..	7.56	41.94	20.94	55.84	44.76	3.36	1,030

1 Nitrogen determinations made by department of agricultural chemistry.

The seed from cotton plants grown upon soil to which fertilizer high in nitrogen has been applied are uniformly higher in nitrogen than seed from plants of the same variety grown during the same season on soil not so liberally supplied with this element—the average difference being less than one half of one per cent. The amount of nitrogen found in the seed from different varieties is fairly constant. In the seed of one variety only, did this variation exceed twenty-three hundredths of one per cent.

The difference in the value of the cotton-seed meal and the hulls, produced by a ton of seed from the variety yielding the most oil and the one yielding the least amount of oil was only forty-four cents, and the increased amount of lint on the seed of the inferior variety more than offset this difference. Therefore, there is practically no difference in the value of cotton seed aside from oil content, and the greatest variation between different varieties of seed in this respect was found in the season of 1914, when the percentages were 23.69 and 17.38, respectively. The average variation for three years was four and forty-two one hundredths per cent., or eleven and eight tenths gallons of oil per ton of seed. Taking the average price of seed for the same three years and the average yield of oil in gallons per ton of seed, it will be found that the price paid for the oil they contained was 82½ cents per gallon. On this basis there is a difference in value of seed from the varieties of high and low oil content shown in the above table of $9.73 per ton.

By eliminating the inferior varieties, the quality of the seed could easily be improved, thereby increasing their average value $5.00 per ton, and the present annual crush of more than five million tons would represent a saving of twenty-five million dollars per annum. This elimination could easily be effected if the seed were purchased on the basis of their oil content, and these data show conclusively that this is the only accurate basis of commercial standardization.

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DEDICATION EXERCISES AT THE BROOKLYN BOTANIC GARDEN

ON April 19–21 exercises were held in connection with the dedication of the completed laboratory building and plant houses of the Brooklyn Botanic Garden. The programs at the various sessions were as follows:

APRIL 19

Formal exercises for officials, Garden members and invited guests. Lecture Hall, Mr. Alfred T. White, chairman of the Botanic Garden Governing Committee, presiding.

Introductory Address, Mr. A. Augustus Healy, president of the Brooklyn Institute of Arts and Sciences.

Address for the City of New York, Hon. William A. Prendergast, comptroller.

The social, educational and scientific value of botanic gardens, Professor John Merle Coulter, University of Chicago.

Addresses for the borough of Brooklyn, Hon. Lewis H. Pounds, president of the borough; for the Department of Parks, Hon. Raymond V. Ingersoll, commissioner of Parks, Brooklyn; for the Brooklyn Botanic Garden, Dr. C. Stuart Gager, director of the Garden.

10 P.M.

Reception by the trustees and woman's auxiliary, inspection of building and view of exhibit on genetics, arranged in cooperation with the Cold Spring Harbor Station for Experimental Evolution of the Carnegie Institution of Washington.

FRIDAY, APRIL 20

Dr. R. A. Harper, Torrey professor of botany, Columbia University, presiding.

A vegetative reversion in Portulacca, A. F. Blakeslee and B. T. Avery, Station for Experimental Evolution, Carnegie Institution.

Intercourses between self-sterile plants, E. M. East, Bussey Institution of Harvard University.

Evolution by hybridization, E. C. Jeffrey, Harvard University.

Binary fission and surface tension in the development of the Volvox colony, R. A. Harper, Columbia University.

The nucleus as a center of oxidation, W. J. V. Osterhout, Harvard University.

Modern applications of botany, Melville T. Cook, Rutgers College.

Mycelium of certain species of Gymnosporangium, B. O. Dodge, Columbia University.

Pathological problems in the distribution of perishable plant products, C. L. Shear, Bureau of Plant Industry, U. S. Department of Agriculture.

Some botanical problems which paleobotany has helped to solve. (Read by title.) Arthur Hollick, Staten Island Association of Arts and Sciences.

The ancient oaks of America. (Read by title.) William Trelease, University of Illinois.

Further notes on the structural dimorphism of sexual and tetrasporic plants in the genus Galaxaura, Marshall A. Howe, New York Botanical Garden.

A quantitative study of Raunkiaer's growth-forms as illustrated by the 400 commonest species of Long Island, N. Y. (Read by title.) Norman Taylor, Brooklyn Botanic Garden.

2 P.M.

Dr. N. L. Britton, director-in-chief, New York Botanical Garden, presiding.

The relation of crown-gall to other overgrowths in plants, Erwin F. Smith, Bureau of Plant Industry, U. S. Department of Agriculture.

The Uredinales of Oregon, Herbert S. Jackson, Purdue University.

The importation of phytopathogenes, W. H. Rankin, Cornell University.

Physiological races of parasitic fungi, George M. Reed, University of Missouri.

The genus *Endogone*, George F. Atkinson, Cornell University.

A method of obtaining abundant sporulation in cultures of *Alternaria solani*, L. O. Kunkel, Bureau of Plant Industry, U. S. Department of Agriculture.

The vegetation of our new West Indian Islands, N. L. Britton, New York Botanical Garden.

Weather conditions and plant development, G. P. Burns, University of Vermont.

American heaths and pine heaths, John W. Harshberger, University of Pennsylvania.

Botanical training in the Agricultural College. (Read by title.) A. Vincent Osmun, Massachusetts Agricultural College.

A duplicated leaf-lobe factor in Bursa, George H. Shull, Princeton University.

Isolation as a factor in specific change, Edmund W. Sinnott, Connecticut Agricultural College.

Further studies on the interrelationship of morphological and physiological characters in seedlings of *Phaseolus*, J. Arthur Harris, Station for Experimental Evolution, Carnegie Institution.

Inheritance studies in Castor beans. (Read by title.) O. E. White, Brooklyn Botanic Garden.

POPULAR SCIENTIFIC PROGRAM

Mr. Alfred T. White, chairman of the Botanic Garden Governing Committee, presiding.

Photographing wild flowers for color illustrations, Dr. Homer D. House, State Botanist of New York.

Vacant lot gardening and children's gardens in Brooklyn, Miss Ellen Eddy Shaw, curator of Elementary Instruction, Brooklyn Botanic Garden.

Problems of conservation in New York state, Hon. George D. Pratt, commissioner of Conservation of New York State.

APRIL 21

Dr. H. M. Richards, Columbia University, presiding.

The synchronism of plant structures, John M. Macfarlane, University of Pennsylvania.

Contact stimulation, G. E. Stone, Massachusetts Agricultural College.

The respiratory ratio of cacti, H. M. Richards, Columbia University.

The absorption of calcium salts by squash seed-

lings. (Read by title.) R. H. True, Bureau of Plant Industry, U. S. Department of Agriculture.

Duplication and cohesion in the main axis in chicory, A. B. Stout, New York Botanical Garden.

The sequence of life in peat bogs. (Read by title.) W. W. Rowlee, Cornell University.

Some observations on the sexuality of *Spirogyra*, H. H. York, Brown University.

The problem of the imported plant disease as illustrated by the White Pine Blister Rust. (Read by title.) Haven Metcalf, Bureau of Plant Industry, U. S. Department of Agriculture.

Outline of the history of the science of phytopathology, H. H. Whetzel, Cornell University.

Tubers within tubers of *Solanum tuberosum*, F. C. Stewart, New York Agricultural Experiment Station.

The rosy-spored Agarics of North America, W. A. Murrill, New York Botanical Garden.

Some botanical-pharmacognostical investigations, Henry Kraemer, Philadelphia College of Pharmacy.

The cytological structure of *Botryorhiza Hippocratcae*. (Read by title.) E. W. Olive, Brooklyn Botanic Garden.

APRIL 21

Conference to consider Vacant Lot Gardening and how the Botanic Garden may become Most Helpful to Teachers

Dr. C. A. King, Brooklyn Institute of Arts and Sciences and Erasmus Hall High School, presiding.

Welcome, Dr. C. Stuart Gager, director of the Brooklyn Botanic Garden.

The possibilities of vacant lot gardening in Brooklyn, Mr. H. F. Button, professor in the New York State School of Agriculture on Long Island.

How may the Botanic Garden cooperate with local schools? Dr. Ralph C. Benedict, Bushwick High School; Miss Beatrice King, Public School No. 25; Miss Johanna Becker, Public School No. 36; Dr. Frederic Luqueer, Public School No. 152; Miss Margaret Kane, Public School No. 98; Mr. James O'Donnell, Public School No. 43; Mrs. Alice Ritter, Public School No. 89.

Opportunities offered by the Botanic Garden, Dr. E. W. Olive, curator of Public Instruction.

What the Botanic Garden is doing for Brooklyn boys and girls. (With brief statements by ten boys and girls.) Miss Ellen Eddy Shaw, curator of elementary instruction; Miss Jean Cross, assistant curator of elementary instruction.

Tea was served at 4:30 P.M. by the Woman's Auxiliary of the Botanic Garden.

THE STANFORD MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The second annual meeting of the Pacific Division of the American Association for the Advancement of Science was held at Leland Stanford Junior University, California, between the dates, April 5 to 7, 1917. The headquarters of the Division were maintained in the rotunda of David Starr Jordan Hall, and the sessions of the several societies participating in the meeting were held in lecture rooms of the departments to which the societies were closely related.

Three general sessions of the division were held, the first of which was a symposium on the afternoon of Thursday, April 5, Dr. J. C. Branner, president of the Pacific Division, presiding. This symposium had been prepared by Dr. D. T. MacDougal, director of the Desert Laboratory of the Carnegie Institution of Washington, Tucson, upon the subject, "Coordination and Cooperation in Research and in Applications of Science." Four addresses were presented as follows:

"Science, and an Organized Civilization," by Wm. E. Ritter, director, Scripps Institution for Biological Research, La Jolla, California.

"The National Research Council as an Agency of Cooperation," by Arthur A. Noyes, director of Chemical Research, Throop College of Technology, Pasadena, California.

"Plans for Cooperation in Research among the Scientific Societies of the Pacific Coast," by J. C. Merriam, professor of paleontology, University of California, Berkeley.

"The Applications of Science," by William F. Durand, professor of mechanical engineering, Stanford University, California.

On the evening of Thursday, April 5, a general session was held in the assembly hall of the Outer Quadrangle, Dr. J. C. Branner, president of the division, presiding. At this session, President R. L. Wilbur welcomed the association on the part of the university, and Dr. James A. B. Scherer, president of Throop College of Technology, responded. In this response President Scherer extended the invitation of Throop College of Technology and other institutions of southern California to the Pacific Division of the American Association to hold its 1918 meeting in Pasadena. The nominating committee presented its report, nominating the following members to serve upon the Executive Committee for a term of three years each: Dr. W. W. Campbell, director of the Lick Observatory, Mount Hamilton; Dr. Wm. E. Ritter, director of the Scripps Institution for Biological Research, La Jolla, California, and Mr. C. E. Grunsky, president of the American Engineering Corporation, San Francisco. This report was accepted and the secretary was instructed to cast the ballot for these names. Following the transaction of this business, Dr. J. C. Branner, the retiring president of the Pacific Division of the American Association, presented his presidential address upon the subject, "Some of

the Scientific Problems and Duties at Our Doors.'' This session was followed by an informal reception to the faculty of the university and to the visiting members of the association at the home of President and Mrs. R. L. Wilbur.

The third general session of the meeting was held on the evening of Friday, April 6, Dr. J. C. Branner, president of the Pacific Division, presiding. At this session the executive committee reported the choice of Pasadena as the place for the 1918 meeting of the division, in response to the invitation given by President Scherer, the time for the meeting to be determined later. The executive committee also reported the election of Dr. D. T. MacDougal, director of the Desert Laboratory, Carnegie Institution of Washington, Tucson, Arizona, as president of the Pacific Division for the ensuing year, and Dr. Barton W. Evermann, director of the Museum of the California Academy of Sciences, San Francisco, as vice-president of the division and chairman of the executive committee for a term of three years. Together with the president and vice-president of the division, the executive committee for the ensuing year includes the three members elected at the previous general session of this meeting, and four members whose terms of office had not yet expired, as follows:

W. W. Campbell, director, Lick Observatory, Mount Hamilton, California,
E. C. Franklin, professor of chemistry, Stanford University, California,
T. C. Frye, professor of botany, University of Washington, Seattle,
C. E. Grunsky, president, American Engineering Corporation, San Francisco,
Vernon L. Kellogg, professor of entomology, Stanford University, California,
E. P. Lewis, professor of physics, University of California, Berkeley,
Wm. E. Ritter, director, Scripps Institution for Biological Research, La Jolla, California.

The following resolution introduced from the Pacific Coast Research Committee was unanimously adopted:

Since experimentation upon animals is indispensable to progress in the biological sciences, for the conquest of disease and for the relief of human suffering,

Be it resolved, That the Pacific Division of the American Association for the Advancement of Science hereby heartily endorses the use, under proper precautions, of unclaimed, impounded animals by the medical schools and universities of the state of California as contemplated in the Prendergast Bill (before the legislature of California).

Professor F. J. E. Woodbridge, of the department of philosophy of Columbia University, then presented a general address upon the subject, ''History and Evolution.''

At a meeting of the Pacific Coast Research Committee on Friday afternoon, April 6, together with representatives of the societies affiliated with the Pacific Division, a Pacific Coast Research Conference was organized. The purpose of this conference is expressed in the following resolution, which was introduced from the Pacific Coast Research Committee, and which was unanimously adopted:

''WHEREAS, It is the opinion of this committee that the important scientific problems before men of science to-day are those problems relating to preparation for war, which require scientific research,

''*Therefore, be it resolved,* That this committee, representing the scientific interests of the Pacific Division of the American Association for the Advancement of Science, offer to the State Council of Defense already formed in California, and to such other similar state or national organizations as may be organized, the full support and assistance of this committee in so far as it may be desired for the direction of research upon problems arising out of a condition of preparation for war.''

Among memorable occasions of the meeting were a series of luncheons given through the courtesy of the university in the Stanford Union on Thursday, Friday and Saturday, April 5 to 7, to which all members of the American Association and affiliated societies were invited. The opportunity for thus meeting in an informal social hour was greatly appreciated by every one.

Eleven societies held sessions on the occasion of this meeting. These were:

California Academy of Sciences,
Astronomical Society of the Pacific,
Pacific Section, American Mathematical Society,
American Physical Society,
Cordilleran Section, Geological Society of America,
Pacific Coast Branch, Paleontological Society,
California Section, American Chemical Society,
Seismological Society of America,
Le Conte Club,
Western Society of Naturalists,
Pacific Slope Branch, American Association of Economic Entomologists.

On the evening of Saturday, April 7, a dinner was held at the Hotel Sutter, San Francisco, under the auspices of the California Academy of Sciences, which was attended by about 85 members of the societies affiliated with the Pacific Division. Mr. C. E. Grunsky, president of the Academy, presided, and informal addresses were given by the following men: Dr. Wm. E. Ritter, Scripps Institution for Biological Research, La Jolla, California; Dr. D. T. MacDougal, Desert Botanical Laboratory, Carnegie Institution of Washington, Tucson; Professor Douglas H. Campbell, Leland Stanford Junior University, California, and J. C. Merriam, University of California, Berkeley.

On the same evening a dinner was held by the American Physical Society at the Stanford Union, Stanford University, and by members of the American Psychological Association at the Hotel Stewart, San Francisco.

On Saturday, April 7, an automobile excursion was conducted under the auspices of the Western Society of Naturalists, into the Coast Range foothills near Stanford University, which was attended by over forty biologists. Luncheon was provided by courtesy of the university at the recently completed field laboratory of the Department of Zoology.

Altogether twenty-two sessions were held during this meeting and over 130 papers were presented. The total registered attendance, in addition to a large local attendance from Stanford University and the vicinity, included 173 members of the association and of affiliated societies from other parts of the state and coast.

ALBERT L. BARROWS,
Secretary

SOCIETIES AND ACADEMIES

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 510th meeting of the society, held at the New National Museum, Dr. Leo J. Frachtenberg, of the Bureau of American Ethnology, Smithsonian Institution, Washington, D. C., presented a paper on "The Religious Ideas of the Northwest Coast Indians."

Dr. Frachtenberg stated that four important features of the religious ideas noted among the tribes of this region are (1) an intensive animism; (2) a belief in the powers of supernatural beings, as dwarfs and giants; (3) a belief in the existence of guardian spirits, and (4) a complete absence of the social phase of religion.

According to Dr. Frachtenberg many religious ideas are common to all the tribes of the northwest coast, yet the northern and southern portions of this area differ in cosmogony. The tribes in the extreme southern portion believe that the world was created out of a watery mist, the Transformer enlarging a small piece of land until it became large enough for habitation. The tribes of the northern portion are satisfied with a world whose origin is not explained, they hold, however, that the Transformer (Creator) first made men, and members of the faunal and floral kingdoms, and later revisited and improved his creation. In the south the Transformer and Trickster are separate individuals; in the north they are unified. In the south the Transformer creates all that is good while the Trickster is held responsible for the bad elements; in the north there is no such disassociation, both good and evil things being regarded as the work of the Transformer.

The northwest coast Indians believe that an individual comprises a body inhabited by two "souls" and a "ghost." In a slight illness the "outer soul" becomes separated from the body, in a serious illness the "inner soul" wanders to the "country of souls" but may be recalled by a shaman. When death occurs the "ghost" also leaves the body and the shaman has no further power.

No ritual or systematic form of supplication is found among these Indians, indeed it may be said that guardian spirits take the place of deities. Every man and woman possesses one or more guardian spirits, each of which has its special sphere of influence. The shamans receive their power from a multitude of such spirits and are both respected and feared. Large gifts are exacted by the shamans, many of whom are believed to possess occult powers of evil.

THE 511th regular and 38th annual meeting of the society was held at the New National Museum on April 17. After approving the reports of the secretary, treasurer and auditing committee the society elected the following officers for the ensuing year: *President,* Mr. William H. Babcock; *Vice-president,* Mr. Francis LaFlesche; *Secretary,* Miss Frances Densmore; *Treasurer,* Mr. J. N. B. Hewitt; *Councillors,* Mr. E. T. Williams, Mr. Neil M. Judd, Dr. Truman Michelson, Mr. Felix Neumann and Dr. I. M. Casanowicz.

Tributes to members of the society deceased during the previous year were then read, memorials to General Ellis Spear, an active member, and Mr. S. M. Gronberger, an associate member, being presented by Mr. William H. Babcock and Mr. James Mooney. A memorial to Mr. J. D. McGuire, an honorary member, was presented by Dr. J. W. Fewkes; and tributes to Professor Johannes Ranke and Professor Gustave Schwalbe, of Germany, honorary members, and Sir Edward Burnett Tylor, a corresponding member of the society, were given by Dr. Aleš Hrdlička, Dr. John R. Swanton, Dr. Truman Michelson and Dr. Leo J. Frachtenberg.

The delivery of the address of the retiring president, Dr. John R. Swanton, on "Some Anthropological Misconceptions," was postponed to a special meeting of the society to be held on May 1 for that purpose.

FRANCES DENSMORE
Secretary

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THE NEBULÆ

Address of the Retiring President of the American Association for the Advancement of Science.[1]

BY W. W. CAMPBELL

Director of Lick Observatory, University of California

It is characteristic of most investigations in pure science that the quest is for the origin and history of things, and for the understanding of what now is, rather than for what is going to occur. One does not wisely venture to predict the future until he has explained the past and accounted for the present. Paleontologists are fruitfully studying the extinct animal life of our planet; several departments of science are busy with the life of to-day; and little effort has yet been made to forecast the animal life of the future. Anthropologists and ethnologists have been concerned with the men and the races of men who have already lived; they are just beginning to think scientifically of the men and the races that are to come. Conditions are moderately different in the one science, astronomy, whose chief domain lies far outside the earth and far beyond our sun. Some of the planets in our solar system may be passing through stages of existence that the earth experienced long ago, and others of our planets may be approximate examples of what is in store for the earth. When we undertake the study of the sun we have the great advantage that millions of suns within our view are representing the stages of stellar life through which our sun is thought to have passed, and millions of others the stages through which our sun will pass in the future. If we seek to know the history of our sun we can not avail ourselves of progressive changes in the sun itself. Such changes are too slow; we think the sun has remained substantially unchanged for hundreds of thousands of years. The student of stellar evolution proceeds by arranging the stars in general in the supposed order of their effective ages, and he endeavors to place our star and our planet at the logical points in the series. In this way astronomers, not unanimously, but in the great majority, have arrived at the conclusion that our own sun is in effect one of the middle-aged stars, and that our earth is in effect a middle-aged planet; and they attempt seriously to predict the future histories of the two bodies.

It is not my purpose to conduct you over the long road of stellar evolution. I shall invite your attention chiefly to the parts which the nebulæ seem to play in the development of the stellar universe; and this will lead me to touch lightly upon the birth and infancy of the stars, and to neglect the periods of their youth, middle life and old age.

[1] Delivered in the American Museum of Natural History, New York City, December 26, 1916. Illustrated by lantern slides.

FIG. 1. (a) N.G.C. 1501. (b) N.G.C. 418. (c) N.G.C. 6543.
Planetary Nebulæ. Composite drawings by Curtis from his photographs with the Crossley Reflector of the Lick Observatory.

The classes of objects with which astronomers have to deal are very few. In our solar system we have the sun, the planets and their moons, the comets, the zodiacal light, and the meteors. To the best of our knowledge that exhausts the list. When we look beyond the solar system and out into the great stellar system we see only two classes of objects: the stars and the nebulæ; but there is an extremely great variety of each class, tens of millions of stars and tens of thousands of nebulæ, probably no two of either class exactly alike.

The serious study of the nebulæ began with Sir William Herschel in the 1780's. In less than two decades his famous sweepings of the sky had rewarded him with the finding of 2,500 nebulæ and star clusters. He did not separate them into a list of nebulæ and a list of clusters, as he was not clear about their relations to each other. When he observed certain of them with small telescopes and low magnifying power they looked like continuous structures, as if they were little clouds of luminous gases; but when some of the same objects were subjected to greater magnification they were resolved into star clusters. Here was the serious beginning of the hypothesis that all the nebulæ would be resolved into stars if only our telescopes were sufficiently powerful. Herschel was not satisfied with this view, and in 1791 he proposed the hypothesis that nebulæ evolve into stars. He thought that nebulæ of great size would condense very gradually, or break up, into smaller nebulæ; that the smaller ones would condense into nebulæ ever more and more regular in outline; and that these would eventually pass into the small, nearly symmetrical objects which he called planetary nebulæ, because in telescopes of low power they presented discs resembling the discs of our planets. He said the planetaries were the immediate forerunners of the stars, and that they would evolve into stars. Herschel actually classified a considerable number of the known nebulæ in accordance with this hypothesis. Speaking of a star surrounded by nebulosity, which is the condition existing in most planetary nebulæ (see Fig. 1), he said that the nebulous matter seemed "more fit to produce a star by its condensation than to depend upon the star for its existence."

Herschel's mind was profoundly philosophic, and his ideas about nebulæ attracted wide attention. They may easily have suggested Laplace's celebrated nebular hypothesis of the origin of our solar system, announced a few years later. Herschel thought of the birth of many stars from the nebulæ; Laplace's hypothesis ventured to describe in detail the process of the develop-

ment of one nebula into our sun, its planets and their moons.

It is necessary for the satisfactory presentation of our subject that we grasp the principal features of our stellar system, and we shall devote a few sentences to its description.

The universe of stars—our stellar system —is believed by astronomers to occupy a limited volume of space that is somewhat the shape of a very flat pocket watch; more strictly, a much flattened ellipsoid or spheroid. It is not intended to convey the impression that the boundaries of the stellar system are sharply defined, nor that the stars are uniformly distributed throughout the ellipsoid (see Figs. 2, 18 and others), but only that the stars are more or less irregularly distributed throughout a volume of space roughly ellipsoidal in form. The thinning out of stars near the confines of the system may be both gradual and irregular. The equatorial plane of the ellipsoid is coincident with the central plane of

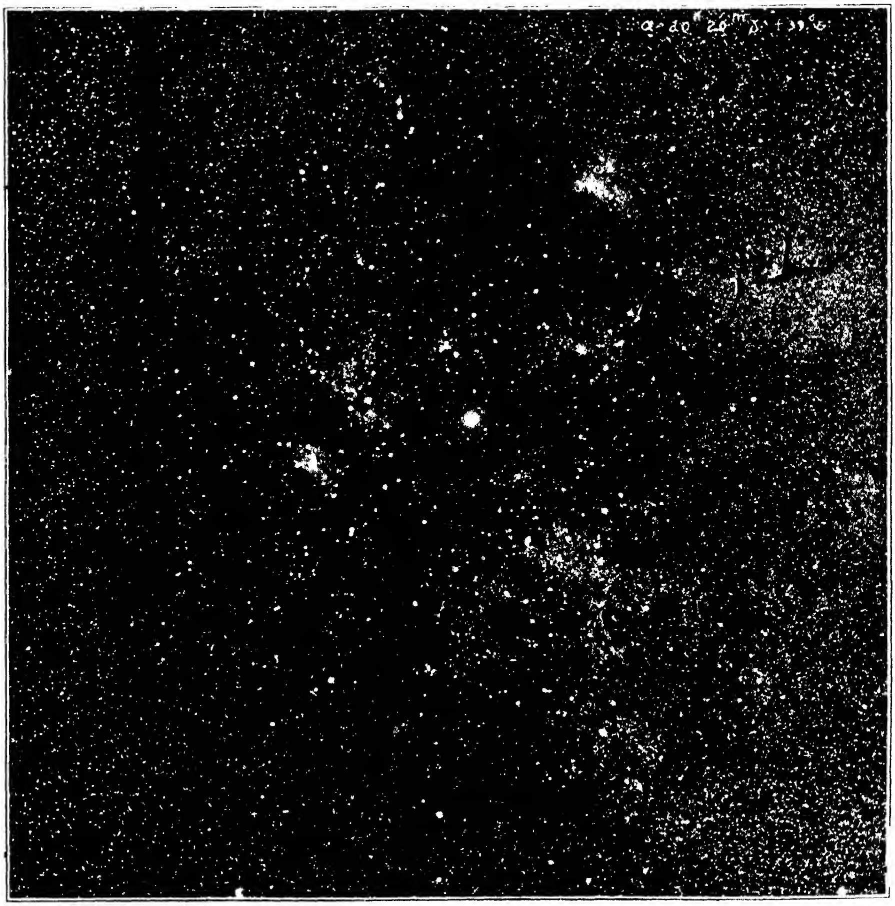


FIG. 2. Milky Way around the star Gamma Cygni, photographed by Barnard with the 10-inch Bruce telescope of the Yerkes Observatory.

the Milky Way. We see the Milky Way, or Galaxy, as a bright band encircling the sky because, looking toward the Galaxy, we are looking out through the greatest depth of stars. There remains considerable uncertainty as to the dimensions of the system, chiefly for two reasons: first, the stars near the surface of the ellipsoid are everywhere too far away to let us measure their distances; and, secondly, the system may be considerably larger than it seems because of possible obstruction of starlight in its passage through space. Newcomb has suggested that the shorter radius of the system, at right angles to the plane of the Galaxy, may be taken as of the order of three thousand light-years. The long radii, those in the plane of the Milky Way, may be at least ten times as great; that is, thirty thousand light-years, or more.

Our solar system is believed to be somewhere near the center of the stellar system: the counts of stars in all parts of the sky do not indicate that any one section of the Milky Way structure is appreciably closer to us, so to speak, than the other sections of it. It should be said that Easton's studies of the Galaxy place its probable center in the rich region of the constellation Cygnus.

These conceptions of the stellar universe and of the Milky Way agree in all important particulars with the ideas of Immanuel Kant published in the year 1755. However, it was the star counts by the two Herschels, father and son, which put this conception of the stellar system upon the basis of confidence. Sir William Herschel, using an eighteen-inch reflecting telescope in the northern hemisphere, and Sir John Herschel, using the same telescope in the southern hemisphere, counted the stars visible in the same eye-piece in 7,300 regions distributed rather uniformly over the entire sky. They found that the number of stars decreased rapidly as they passed from the central plane of the Galaxy toward the north and south poles of the Galaxy. Here is a table deduced by Struve from the Herschels' counts:

Galactic Latitude[2] Zones	Average Number of Stars Per Field 15′ in Diameter
$+90° - +75°$	4.32
$+75 - +60$	5.42
$+60 - +45$	8.21
$+45 - +30$	13.61
$+30 - +15$	24.09
$+15 - 0$	53.43
$0 - -15$	59.06
$-15 - -30$	26.29
$-30 - -45$	13.49
$-45 - -60$	9.08
$-60 - -75$	6.62
$-75 - -90$	6.05

The average number of stars in the Milky Way zone 30° wide, that is, between galactic latitudes + 15° and — 15°, visible in the eyepiece of the telescope, was fifty-six,[3] whereas in the regions surrounding the north and south galactic poles (latitudes between 75° and 90°) the average visible in the same eyepiece was but five.[3] The great condensation in the Milky Way is not fully evident from the table. The stars are much more numerous near the central line of the Milky Way than they are near its borders. The average number along the central line found by Sir William Herschel was 122. There is no reason to doubt that the pre-

[2] The galactic latitude of a star is its angular distance from the nearest point of the central line of the Galaxy, in the same way that the terrestrial latitude of a city is the city's angular distance from the nearest point of the earth's equator.

[3] A recent study of Mr. Franklin Adams's photographs of the sky, by Chapman and Melotte, shows a considerably smaller ratio than the 56:5 found by the Herschels. Seares has recently determined from Mount Wilson photographs that the number of stars per square degree along the central line of the Milky Way is more than twenty times as great as the number per square degree near the galactic poles; a result in remarkably close confirmation of the Herschels' counts. The source of the discordance between Chapman and Melotte's results and Seares's results remains unexplained.

FIG. 3. The Spectrum of the Great Spiral Nebula in Andromeda, photographed by Slipher at the Lowell Observatory.

[The series of bright lines along the upper and lower margins are the reference spectrum. The nebular spectrum runs horizontally through the central area.]

ponderance of stars visible in the Milky Way is due to the greater extension of the stellar system in that direction than in the direction of the galactic poles.

Sir John Herschel, the son, extended the father's search for nebulæ to the southern sky, by observing at the Cape of Good Hope in the 1830's. He later charted all of the known nebulæ, both north and south, upon a sphere representing the entire sky, and found the surprising condition that the nebulæ in general avoid the Milky Way. Several decades earlier William Herschel had noticed within the Galaxy that the nebulæ are the more plentiful where the stars are scarce. When the stars in the eyepiece of his telescope would suddenly change from numerous to few he was accustomed to say to his recording assistant, "Get ready, nebulæ are coming." These general facts of stellar and nebular distribution, where stars are scarce nebulæ abound, and where stars abound nebulæ are scarce, led Herbert Spencer, among others, to emphasize the view that the evidence for a relationship of stars and nebulæ is overwhelmingly strong. This he called "the relationship of avoidance."

In the year 1864 occurred a great astronomical event. William Huggins pointed his spectroscope to a well-known planetary nebula in Draco (Fig. 1, *c*) and found that its visible spectrum consisted of three isolated bright lines (see Fig 32, N. G. C. 6543, the three lines at the right end of spectrum). This observation gave a death blow to the hypothesis then prevailing that all the nebulæ would prove to be clusters of stars if only our telescopes were powerful enough, or if the nebulæ were brought near enough to us. The spectroscope said very definitely and with finality: the Draco nebula is unresolvable; it is a mass of glowing gases. A cluster of stars can not give that type of spectrum. Other nebulæ were tested by Huggins's spectroscope. Some of these objects gave bright-line spectra, but the great majority had continuous spectra. Whether the latter were actually continuous or, as in the case of the sun and other middle-aged stars, the apparently continuous spectra of the nebulæ were really interrupted by hundreds and thousands of absorption lines, could not be decided because the nebular spectra were exceedingly faint. The eye could not have seen the absorption lines even if they were present. It is only in the last two decades, through the use of rapid photographic plates and of exposures a great many hours in length, that the existence of absorption lines in the continuous spectra of the nebulæ (see Fig. 3) has been proved for all of the nebulæ submitted to adequate test.

Lord Rosse's famous six-foot reflecting telescope marked an epoch in nebular research, in the year 1845, by showing that certain well-known nebulæ are of spiral structure—pretty certain evidence that they are in rapid rotation. Roberts's

photography of nebulæ in the '90's added to our knowledge of them, but the number of spirals known to exist was still not more than two or three dozen out of the approximately 10,000 objects listed in Dreyer's General Catalogues of nebulæ and clusters.

Fig. 4. Spiral Nebula Messier 81, photographed by Keeler with the Crossley Reflector of the Lick Observatory.

A great impetus was given to the study of the nebulæ when Keeler began to photograph them, in 1898, with the Crossley reflecting telescope of the Lick Observatory. His photographs, covering small areas in many different parts of the sky, recorded hundreds of nebulæ hitherto unseen. Using these small photographs as sample tests of nebular distribution, he estimated conservatively that his telescope could discover at least 120,000 nebulæ in the entire sky whenever he cared to undertake the work. Keeler's photographs were revolutionary in another sense: they led him to the capital discovery that the great majority of the nebulæ are spirals. Keeler's results have been abundantly confirmed by later observers: Perrine, Wolf, Fath, Curtis and others. Using the sixty-inch reflector of the Mount Wilson Solar Observatory, Fath photographed 139 small areas uniformly distributed over the northern three fifths of the sky, and he estimated from the number of the nebulæ recorded on his small plates that similar photographs completely covering the sky, 22,000 photographs, would

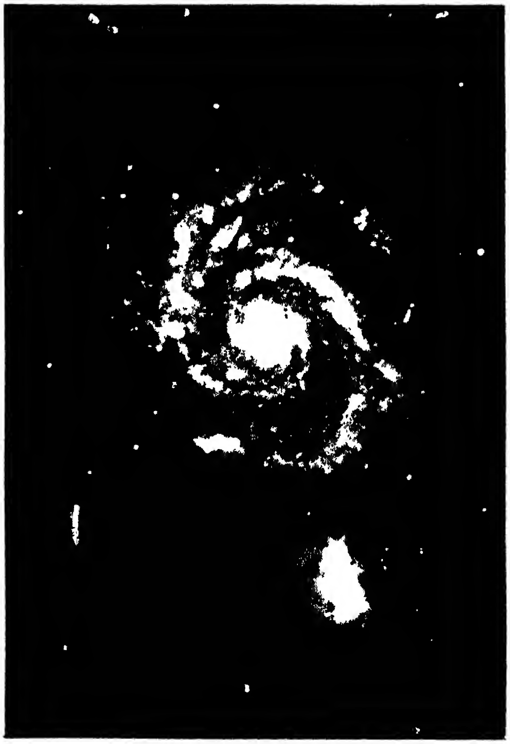


Fig. 5. Spiral Nebula Messier 51, photographed by Curtis with the Crossley Reflector of the Lick Observatory.

record about 162,000 nebulæ. Perrine, using the Crossley reflector, estimated the number discoverable as still greater. All the observers have found the faint nebulæ to present a variety of elliptic forms, such as we should expect if they are spirals

whose principal planes are distributed in direction at random. Many of them are approximately circles, as if they are spirals seen flatwise (Fig. 5); others appear as

FIG. 6. Spiral Nebula, edgewise, N.G.C. 4244, photographed by Keeler with the Crossley Reflector of the Lick Observatory.

spindles, or as spirals seen edgewise (Fig. 6); and the great majority have intermediate elliptic forms (Fig. 7). The plain inference is that the very faint nebulæ are for the most part, and perhaps almost entirely, spirals.

We have mentioned Sir John Herschel's charting of the nebulæ with reference to their distribution over the sky. Proctor charted all the nebulæ and star clusters known up to 1869, as in the illustration (Fig. 8). The positions of the nebulæ are indicated on the charts by the small dots. Their peculiar relationship to the Galaxy is apparent. The star clusters are plotted on the charts as crosses. It is clear that the clusters are found prevailingly in the galactic regions and in the two Magellanic Clouds (see Figs. 22 and 23), the Greater and the Lesser, which are about 20° from the south pole of the sky and are far to one side of the Galaxy. We should perhaps explain that the two Magellanic Clouds are great clusters of stars and nebulæ, covering many square degrees each, which have the same general appearance as many of the cloud forms of the Galaxy itself. We shall later find reason for believing that these Clouds are isolated stellar systems, separate from and independent of our stellar system.

It is the small star clusters, the clusters of rather widely separated stars, and the clusters of irregular form which show the strongest preference for the galactic regions; and there is no reason to doubt that all of such clusters belong to our system. The globular clusters, rich in stars and symmetrical in form, of which only 83 are known in the whole sky, likewise show a strong preference for the Milky Way, and it is probable that most of them, in fact nearly all of them, are within our stellar system; but the greatest of these clusters,

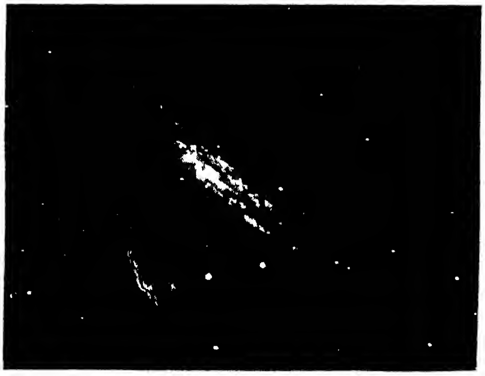
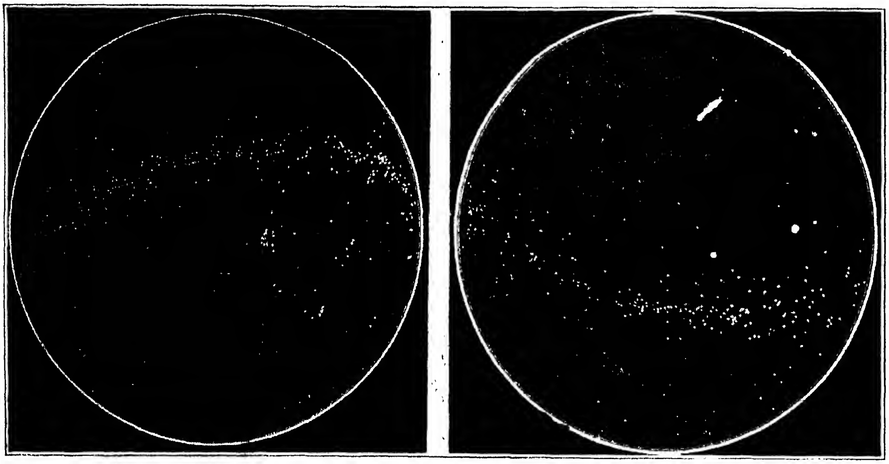


FIG. 7. Spiral Nebula N.G.C. 253, photographed by Keeler with the Crossley Reflector of the Lick Observatory.

such as the cluster in Hercules, and two clusters even more prominent in the southern sky, are seen at considerable angular distances from the Milky Way structure.



Southern Hemisphere. Northern Hemisphere.

FIG. 8. Distribution of Nebulæ and Star Clusters according to Proctor. Nebulæ are marked by dots; clusters by crosses.

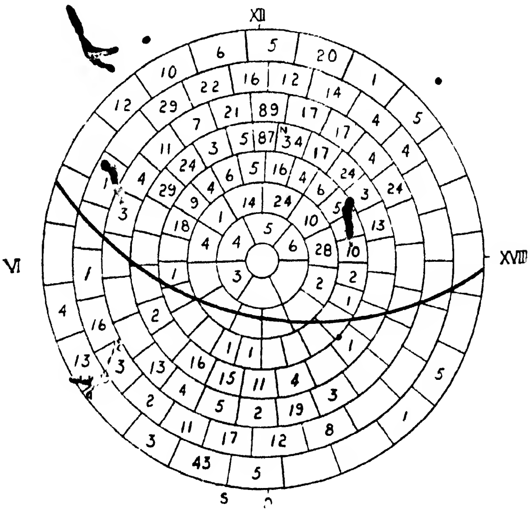


FIG. 9. Distribution of Faint Nebulæ discovered by Fath at Mount Wilson.

Fath's photographs, covering very small areas in the centers of 130 regions, recorded nebulæ hitherto undiscovered in the numbers set down in his chart, reproduced in Fig. 9. The curve drawn across the chart represents the central line of the Galaxy. The north pole of the Galaxy is at N, and the south pole is near S at the lower edge of the diagram. The distribution of the nebulæ is seen to be irregular and patchy, but the fact is indisputable that the faint nebulæ discovered with the most powerful photographic telescopes in the world, like the brighter nebulæ discovered visually by the Herschels and others, abhor the Milky Way. In the northern hemisphere, as

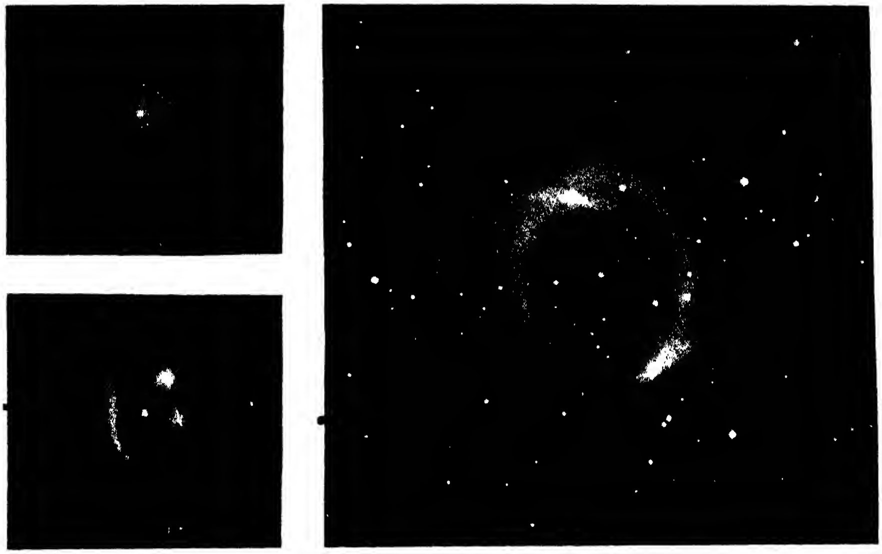


FIG. 10. Planetary Nebulæ. (a) and (b) are composite drawings from photographs, and (c) is a direct copy of a photograph, made by Curtis with the Crossley Reflector of the Lick Observatory.

(a) N.G.C. 351. (b) N.G.C. 6818. (c) N.G.C. 7293.

1 inch = 8′.5.

Herschel and Proctor had established, they cluster more densely in the neighborhood of the pole of the Galaxy. In the southern hemisphere they show the same tendency, but not so strongly marked.[4] Two or three hundred of the brighter nebulæ have long been known to exist in and near the Milky Way, but faint nebulæ, such as those scores of thousands which Keeler showed are still awaiting discovery, are practically non-existent in the galactic region.

Let us examine more carefully the distribution of the nebulæ with reference to the Galaxy, and with reference to the physical conditions which seem to exist within them.

Out of approximately fifteen thousand nebulæ thus far discovered, fewer than 150 are planetaries. They exist in a variety of sizes, from a few that are only two or three seconds of arc up to others a quarter of a degree in diameter. The difference in size is due, at least in large part, as Curtis has recently made clear, to a difference in the distances of the bodies from us. A considerable number of them appear to be more and more condensed as we approach their centers, but the ring-form planetaries are the prevailing type (see Fig. 10). These rings of nebulosity are apparently not true rings, existing chiefly in two dimensions, but ellipsoidal shells of matter seen as rings in projection on the background of the sky. If they were true rings, we should see some of them as extremely elongated ellipses, and others ought to be long and slender as a result of seeing them edgewise. Those forms are wholly unknown. Now all of the planetaries give spectra consisting chiefly of isolated bright lines (see Fig. 32); that is, they are gaseous in constitution, and are

[4] It is not intended to convey the impression that the nebular distribution is merely a function of the galactic latitude; the observed nebulæ are more numerous in certain galactic longitudes than in others.

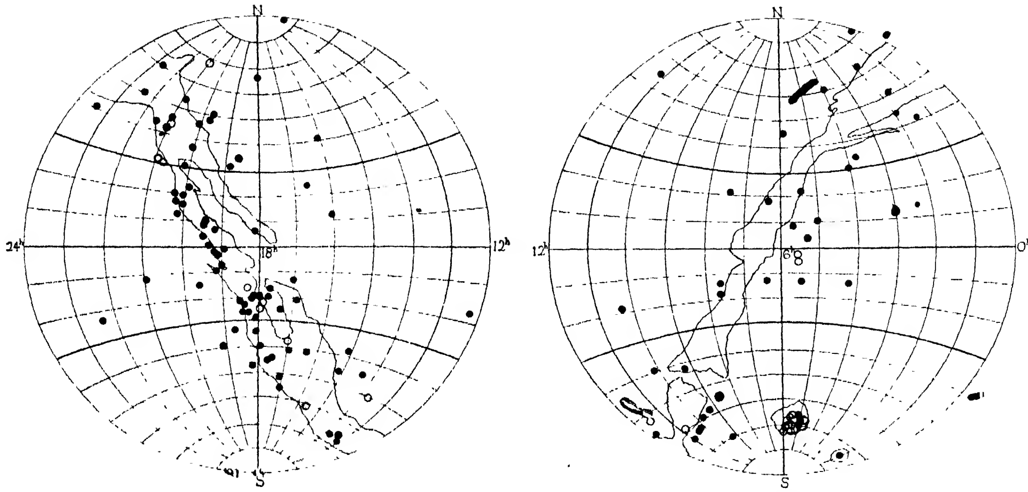


FIG. 11. Distribution of Planetary and Irregular Bright-line Nebulæ.
Right Ascen. 12h to 24h. Right Ascen. 0h to 12h.
● = Planetary nebulæ. ○ = Irregular bright-line nebulæ.
The irregular lines enclose the brighter galactic structure.
The positions of the Greater and Lesser Magellanic Clouds are shown above and to the right of the south pole of the right-hand chart.

shining by their own light. A very large proportion of them are in or adjacent to the structure of the Milky Way, or in the Magellanic Clouds (see Fig. 11). There are a few exceptions, but the exceptions almost certainly find their explanation in the relative nearness of these few to us, so that, being a little to one side of the central plane of the stellar system, they are seen in projection at some distance to one side or the other of the galactic structure.

The large irregular nebulæ whose spectra are known to consist of bright lines are charted as open circles. Such nebulæ at a considerable distance from the Galaxy are very scarce indeed.

The motions of approach and recession of the bright-line nebulæ have been observed with spectrographs at the Lick and D. O. Mills observatories. The large and formless bright-line nebulæ, such as the Trifid and Orion nebulæ, are almost at rest amongst the stars; their individual velocities are small, and the mean velocity of the group, with reference to our stellar system, is zero. These nebulæ, considered as a system, are not moving through the stellar system. They are in it and a part of it. Many of the planetary nebulæ (see Figs. 1 and 10) have high velocities, as individuals, but when we consider them collectively their motion with reference to the stellar system is in effect zero. They too are of our system.

There are in or not very far from the Milky Way many irregular nebulæ, of a great variety of sizes, whose types of spectra are for the most part unknown. They are intrinsically faint, and their investigation is a most promising problem of the immediate future. Two of these nebulæ, according to Slipher, have spectra identical with the brilliant stars which seem to be immersed in them; that is, continuous spectra, except as the absorption lines of helium and hydrogen are present in both

the nebular and the stellar spectra. These facts have led Slipher to favor the view that the two nebulæ are not shining by their own light, but by the reflected light of the brilliant stars in their midst. One of these is the nebula in which the Pleiades cluster is immersed (Fig. 13), and the other is around the bright star Rho Ophiuchi (Fig. 14). There are in the Milky Way many scores of nebulæ such as these, though for the most part fainter; but whether their spectra are of the bright-line type or reflected-light type, we do not know.

Our photographic telescopes are confirming William Herschel's observation that these large and formless nebulæ are in or are bordered by regions of sky showing fewer stars than abound in the surround-

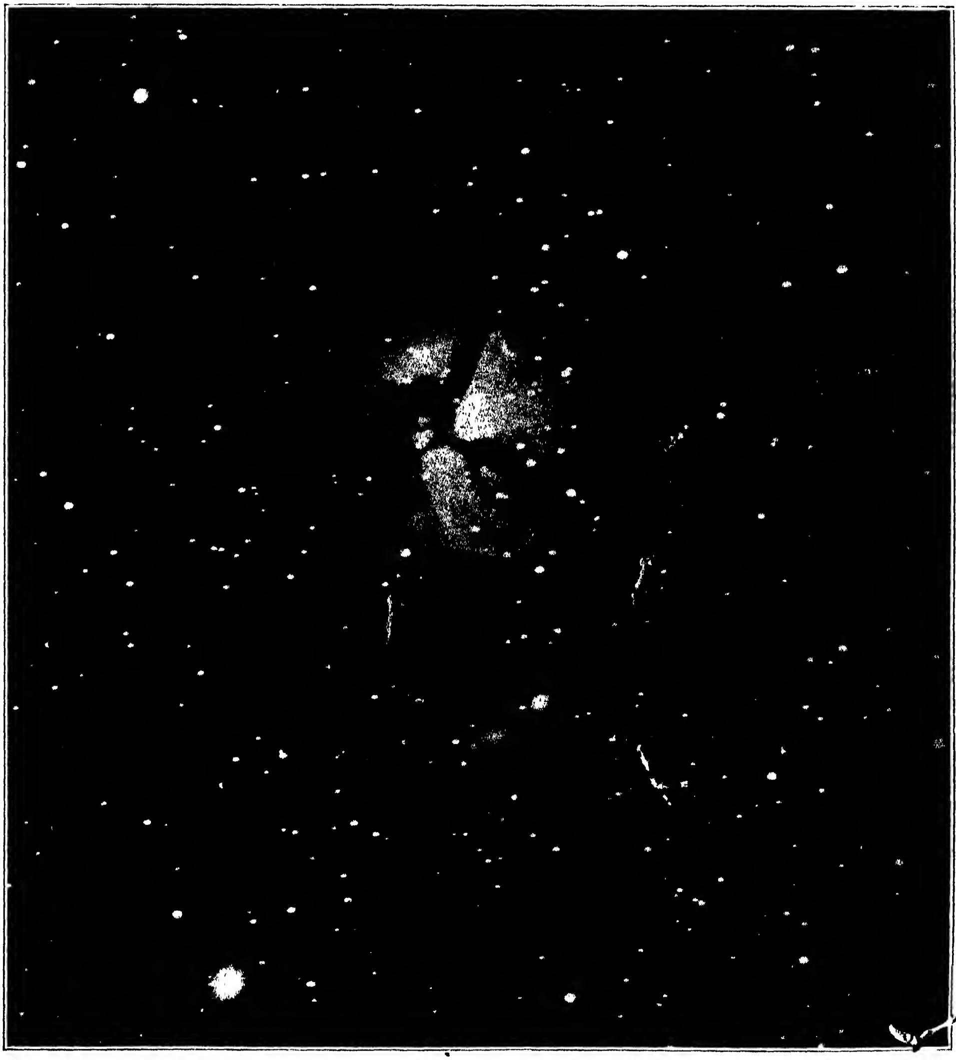


FIG. 12. The Trifid Nebula, in Sagittarius, photographed by Keeler with the Crossley Reflector of the

E

Fig. 13 The (inner) Pleiades Nebula, photographed by Keeler with the Crossley Reflector of the Lick Observatory. (By engraver's error the plate is reversed in one direction, as indicated by the letters W, N, E, S.)

ing regions. The bright stars in the Pleiades, those really belonging to the cluster, are numerous, but within the cluster as we see it, and in a considerable area of the adjacent sky, the faint stars are markedly scarcer than in the areas farther away. Barnard has found that the sky in the region around the Pleiades group is possessed of much nebulosity. It is a natural question, are the faint stars scarce because the nebulosity there existing has not yet condensed into stellar forms? This may be true in part, but we shall find much more probable the view that the faint stars are deficient in numbers because the nebular materials, at a certain distance away from us, are obstructing the light of the faint stars that are farther away from us than

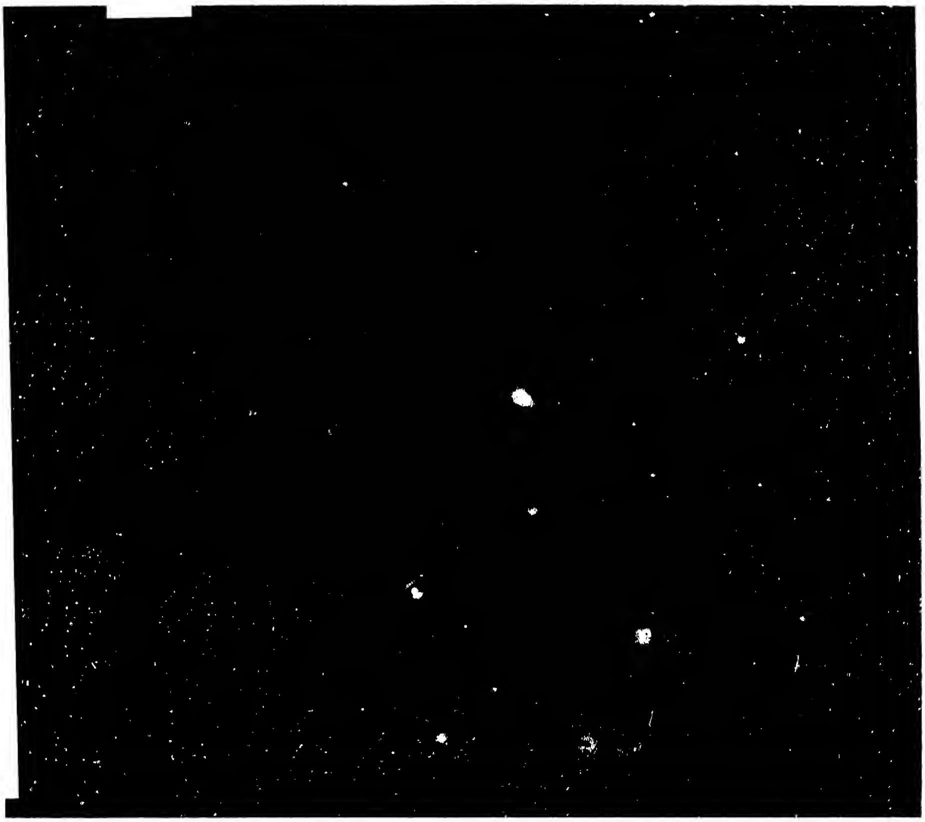


FIG. 14. The Milky Way around Rho Ophiuchi, photographed by Barnard with the 10-inch Bruce Telescope of the Yerkes Observatory.

the nebula is. A similar deficiency of faint stars exists within the great nebula of Orion, and likewise in the adjacent areas, where Mr. William H. Pickering has found a very large part of the constellation of Orion to be covered with faint nebulosity. We shall give illustrations of several regions (see Figs. 14, 15, 16) where this condition —the presence of nebulosity and the scarcity of faint stars—is so marked as to be at once apparent. There are so many regions in and near the Galaxy where these relationships exist that we can not doubt their significance. The faint stars are relatively scarce chiefly because the nebular materials cut off the light of the more distant stars. This explanation is reached by several lines of evidence, but we take time to present only one.

It is established by modern astronomy that the individual stars are in rapid motion. The speeds of the naked-eye stars average about sixteen miles per second. The distant fainter stars, so far as they have been observed, are also traveling rapidly. There is a tendency to favor certain directions of motion, and the stars in certain small groups are keeping company through space; but a large share of stellar motion is at random. There are stars traveling in all directions. We have not the direct evidence as to the motions of the

faint stars in the far distant outposts of the Galaxy, but we have no reason to suspect that their characteristic motions are unique. We can see no escape from the condition that all the stars are in motion. Under these circumstances we are unable to explain how within a great volume of

FIG. 15. Irregular Nebula N.G.C.$_2$ 5146, photographed by Curtis with the Crossley Reflector of the Lick Observatory.

(The circular halos around the brighter stars are unavoidable defects and are not real.)

space that is rich in stars there can be a smaller, but still enormous volume of space, nearly free of stars. Their random motions should distribute them more uniformly than we observe to be the case. Let us illustrate by the celebrated black holes, the so-called "coal sacks," in the constellation of Sagittarius (Fig. 17). In a region where the stars are especially plentiful are two small areas all but empty of visible stars. An enlargement of a photograph by Barnard, the preeminent student of this subject, shows the effect still better. How can such great "holes" through the stellar system be surrounded by a plenitude of stars moving more or less at random so as to give a high density of star distribution right up to the sharply defined edges of the holes, and yet leave the holes empty of stars? With the help of all astronomical experience we can not explain the phenomena by the absence of stars. I think we must assume, with Barnard and others, that the stars are actually there, and that they are invisible because invisible materials between us and the stars are absorbing or occulting the light which the stars are trying to send us. Much of the interesting structure in the Milky Way is probably due in a like manner to obstruction by materials lying between us and the great clouds of stars (see Fig. 18). It is characteristic of the galactic structure that where luminous nebulæ seem to reduce the numbers of faint stars visible, the reduction in numbers of stars extends also far out beyond the limits of visible nebulosity (see Figs. 14, 15 and 16), and we can scarcely resist the conclusion that invisible extensions of the luminous nebular fabric exist as obstructing agents.

There are many other lines of evidence in support of the hypothesis that invisible matter exists in abundance within the stellar system:

1. Newcomb and Kelvin, working independently and on the assumption that the motions of the stars are generated by gravitational attractions originating within the stellar system, were unable to account for the high observed velocities of stars, except on the hypothesis that the visible stars contain only a small fraction of the matter existing in the system; the greater part of the attracting material in the stellar sys-

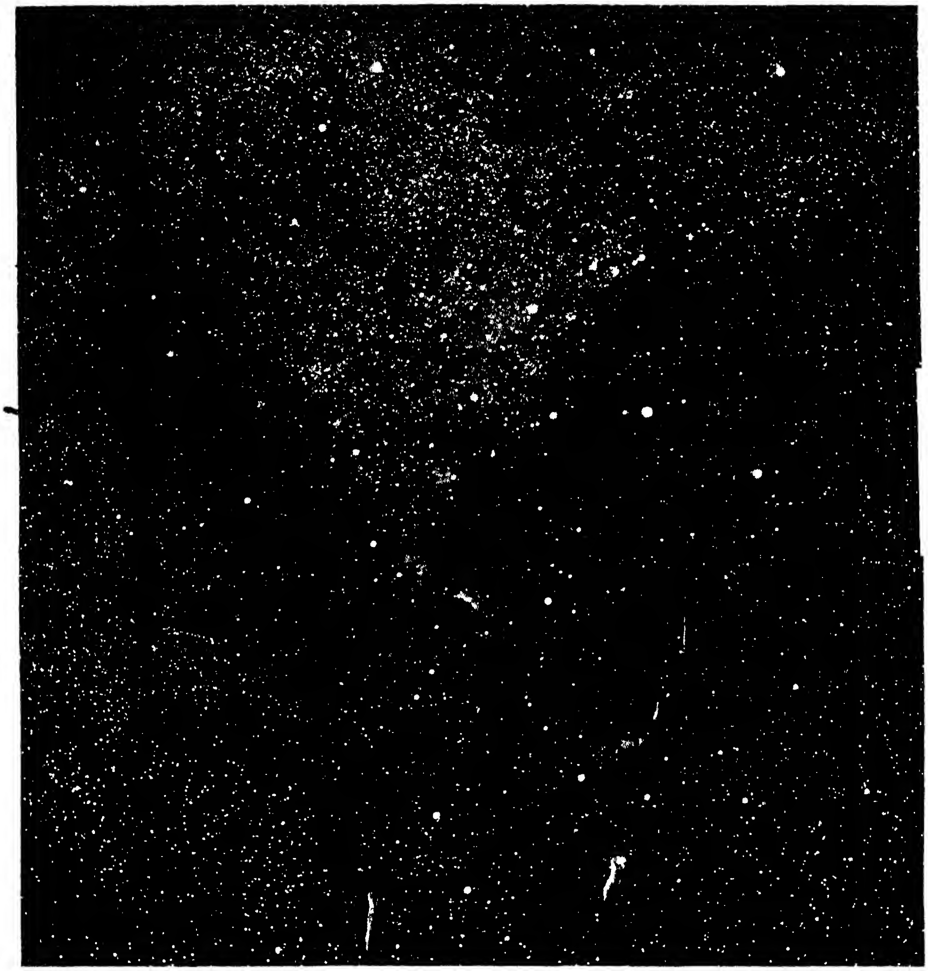


FIG. 16. The North America Nebula, photographed by Barnard with the 10-inch Bruce Telescope of the Yerkes Observatory.

tem being non-luminous, or at least invisible.

2. There must be an enormous amount of comet material distributed throughout space. The astronomers discover only a negligibly small proportion of the comets which pass near the center of our solar system. May not comet materials exist also in abundance in the systems of the other stars?

3. Students of meteors have established that the separate little bodies which collide with the earth's atmosphere and are responsible for the so-called shooting stars are stupendous in numbers. It has been estimated that as many as twenty or thirty millions of such bodies collide with the earth every twenty-four hours. How incomparably and inconceivably greater must be the total number in our solar system. The power of these countless particles to obstruct the passage of light is not negligible. There may be as many such particles on the average around the other stars in our stellar system.

4. The so-called new stars, otherwise known as temporary stars, afford interesting evidence on this point. These are stars which suddenly flash out at points where previously no stars were known to exist; or, in a few cases, where a faint existing star has in a few days become immensely brighter. Twenty-nine such stars have been observed in the past three centuries, nineteen of them since 1886 when the photographic dry plate was applied systematically to the mapping of the heavens, and fifteen of the nineteen are to the credit of the Harvard observers. This is an average of one new star in less than two years in the last three decades; and, as some of the fainter new stars undoubtedly come and go unseen, it is evident that they are by no means rare objects. Now all of the temporary stars except five appeared in the Milky Way, and four of the five exceptions are worthy of note. Two of the five appeared in well-known nebulæ; another was located close to the edge of a spiral nebula, and quite probably in a faint outlying part of it; a fourth was observed to have a nebulous halo about it; and the fifth was but meagerly and imperfectly observed. Keeping the story as short as possible, a temporary star is seemingly best explained on the theory that a dark or relatively dark star traveling rapidly through space has met with resistance, such as a great nebula or cloud of particles would afford. While passing through the cloud the star is in effect bombarded at high velocity by the resisting materials. The surface strata become heated, and the luminosity of the star increases rapidly. The new star of February, 1901, in Perseus afforded interesting testimony. Wolf at Heidelberg photographed in August an irregular nebulous object near the star. Ritchey's photograph of September showed extensive areas of nebulosity in all directions from the star. In October Perrine and Ritchey discovered that the nebular structure had apparently moved outward from the star (see Fig. 19). Going back to a March photograph, taken for a different purpose, Perrine found recorded upon it an irregular ring of nebulosity closely surrounding the star which was not visible on later photographs. The region seemed to be full of nebulosity not visible to us under normal conditions. The rushing of the dark star into and through this resisting medium made the star the brightest one in the northern sky for several days. The great wave of light going out from the star when at this maximum brightness traveled far enough in five weeks to fall upon non-luminous materials and made a ring of nebulosity visible by reflection. Continuing its progress, with a speed of 186,000 miles per second, the wave of light illuminated the material which Wolf photographed far away from the star in August, the material which Ritchey photographed still farther away in September, and the still more distant materials which Perrine and Ritchey photographed in October, November and in later months. We

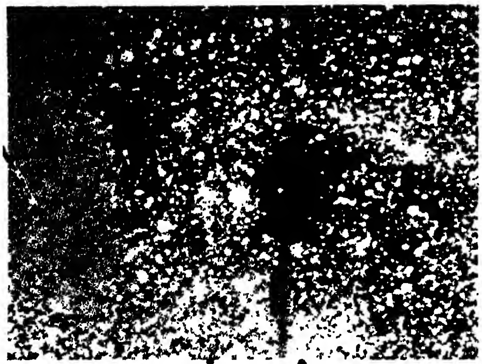


Fig. 17. The Dark Holes, or "Coal Sacks," in Sagittarius, photographed by Barnard with the 10-inch Bruce Telescope of the Yerkes Observatory.

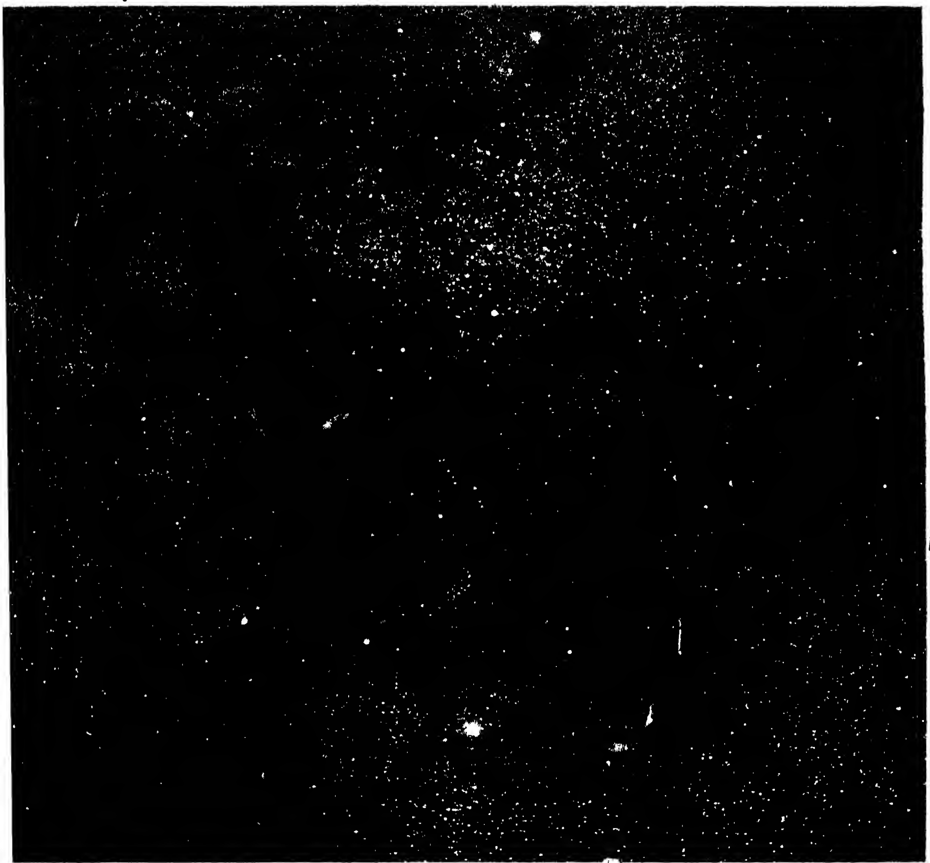


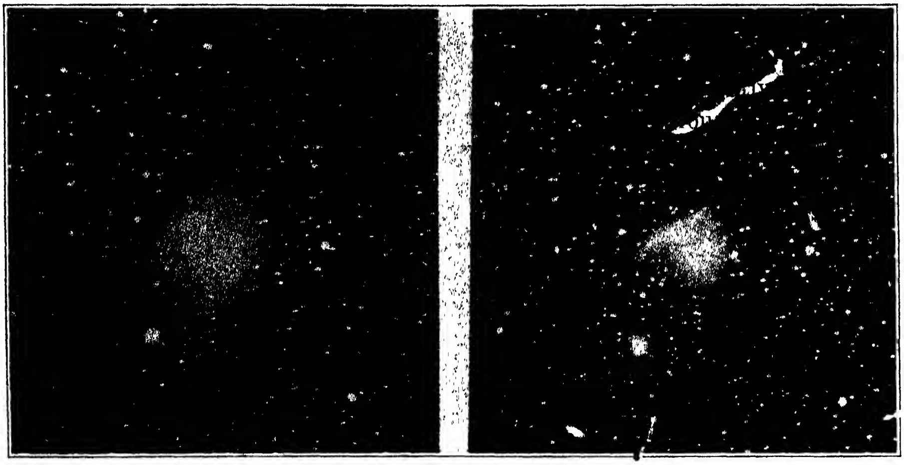
FIG. 18. The Milky Way in Ophiuchus showing apparent absorption or obstruction effects; photographed by Barnard with the 10-inch Bruce telescope of the Yerkes Observatory.

were able to see this material only as the very strong wave of light which left the star at maximum brightness made the material luminous in passing.

We can scarcely doubt, in view of all these facts, that there is a stupendous amount of obstructing material scattered throughout our stellar system. This may eventually be condensed into stars; but the point I wish to emphasize is that the material is there, and is evidently obstructing the passage of light. The efficiency of the obstructing material is no doubt the greater in the long dimensions of the system; in the direction of the Milky Way.

Let us now consider the nebulæ which are not in or near the Galaxy. The overwhelming majority of the stars are in the galactic zone of the sky. If we call this zone 30° wide, which makes it a shade over one fourth the entire sky, we may say that this fourth-area contains certainly three fourths of all the stars known to exist in our stellar system. The remaining three fourths of the sky do not show more than one fourth of all the stars. Of about 15,000 nebulæ recorded probably not over 300,[5] certainly

[5] It is not practicable to state the number more definitely. To illustrate the difficulty, we mention



November 12 and 13, 1901. January 31 and February 2, 1902.

Fig. 19. Apparent movement of nebulous matter about Nova Persei. Photographed by Perrine with the Crossley Reflector of the Lick Observatory.

[The motion is best shown by the bright mass above and to the right of the center, in comparison with the surrounding stars.]

not over 400,[5] are found in the galactic zone. That is, not more than one fortieth or one fiftieth of the known nebulæ are in that one fourth of the sky which contains the Milky Way; and these possible 400 galactic nebulæ include nearly all of the planetary nebulæ, nearly all of the large gaseous nebulæ, nearly all of the regions where large absorbing or obstructing nebulæ are seen to be effective; in other words, as I have endeavored to make clear, nearly all of the nebulæ that are really within our stellar system. The other three quarters of the sky contain, on the contrary, nearly 15,000 recorded nebulæ. The nebulæ to the south of the galaxy have not been so well observed as those to the north, and we shall here consider the northern galactic hemisphere alone. The one quarter of the northern hemisphere immediately around the pole of the Galaxy contains three fourths of all the recorded nebulæ in the whole hemisphere, and the quarter of the hemisphere adjoining the central line of the Galaxy contains about one fiftieth of all the recorded nebulæ in the hemisphere. The density of nebular distribution in the Galaxy is only one fortieth that in the quarter-area farthest away from the Galaxy. A still more interesting fact concerning nebular distribution is this: *thousands of spiral nebulæ are known to exist, but not a single spiral nebula has been found within the galactic structure.* Some spirals have been found in regions adjoining the Galaxy, but they are relatively few. The spirals in particular abhor the Milky Way. As we said above, the very avoidance of the Milky Way seems at first sight to show that they are arranged with reference to it; that they hold some relation to it. Is this relationship real, or only apparent? Are the spiral nebulæ in or attached to our system, or are they outside of our system, at tremendous distances from us? This question is a live one in the astronomy of to-day. The old hypothesis that the unresolved nebulæ are

corded with a short exposure may be seen to be but parts of one great nebula when the exposure is longer.

other great universes of stars very far distant from our own universe of stars is receiving favorable consideration, as far as the spiral nebulæ are concerned. In fact, the related hypothesis that our own stellar system, if viewed from a stupendous distance, would be seen as a spiral nebula, has been seriously proposed and is receiving favorable consideration. There is much merit in the hypothesis that if an observer went very far away from our system, in the direction of one of the poles of the Galaxy, and looked back to our stellar system, he would see it fairly circular in outline, and that the cloud forms which we see in the galactic structure would to the distant observer resemble the ill-defined condensations so characteristic of the outer structure of spiral nebulæ (see Fig. 5). If the observer were at a very great distance outside of our system in the plane of Milky Way extended, we certainly think he would see our system as a greatly elongated ellipse resembling the many well-known spindle nebulæ which are interpreted as spirals seen edgewise (see Fig. 6).

Whether we regard the spirals as very large bodies at enormous distances, far outside and independent of our system, or as within our system and therefore comparatively small bodies close to us, we encounter apparent difficulties of interpretation. These proceed chiefly from their avoidance of the direction of the Milky Way. We are not content to think of this relationship of avoidance as a coincidence or accident of nature. If the spirals are far outside our system, we should expect to see a great many of them in the direction of the Milky Way, but beyond its structure.

We have seen reasons for believing, or at least strongly suspecting, that there is an immense amount of obstructing material in our system, and that this would be the most extensive and the most effective in the long dimensions of our system, and the least effective in the direction of the short axis of the system. If such obstructions are operating effectively upon the light of extremely faint and extremely distant nebulæ, they should produce something like the distribution which we actually observe to exist amongst the spirals.

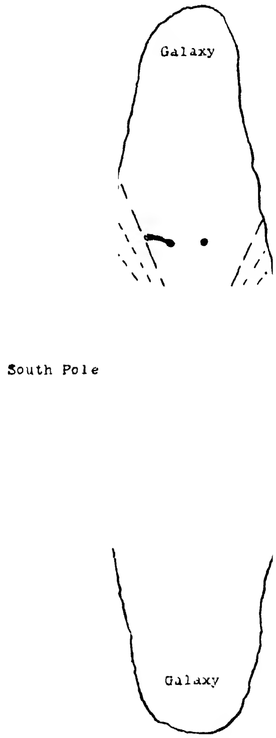


Fig. 20. Hypothetical Cross section of our Stellar System, showing spaces N and S occupied by the spiral nebulæ if they are within the stellar system.

Let us suppose, on the other hand, that the spirals are in our system. Why do we not find them in the Milky Way structure? Why do they absolutely avoid that structure? Why do they congregate around the shorter axis of our stellar system? If they are within our system they must be distributed as to distance and direction somewhat as sketched in the conical volumes N and S in Fig. 20, which represents a cross-section

of the stellar system, with the solar system somewhere near its center. This is an assumed distribution which leads straight into difficulties and to some degree of absurdity. We should have to say that the spirals live close to the right of us and close to the left of us, but that they avoid getting between us and the Milky Way structure.

Slipher has measured the motions of approach and recession of more than a score of prominent spirals, and he finds they are moving with speeds surprisingly high, running up to 600 or 700 miles per second, with an average of roughly 250 miles per second. Now, if they are moving at random, which is the probable approximate truth, their average speed at right angles to the line of sight must be still higher, and their average speed in space would be of the order of 500 miles per second. There is no class of objects known to exist within our stellar system which have velocities at all approaching that scale.

Curtis has conducted an extensive investigation to determine whether and how much the principal spiral nebulæ have moved on the surface of the sky in the last fifteen years, on the basis of photographs taken at the beginning and at the end of that period. Lampland and van Maanen have similarly sought for evidences of change of position of three or four spirals. The indications of motion in all these cases are so slight as to leave us uncertain whether the motions of the brighter and larger spirals across the face of the sky in fifteen years have been sufficient for detection. Harmonizing this fact of their vanishingly small angular motions with Slipher's high speeds in miles per second, we conclude that they must be enormously distant, and therefore enormously large bodies.

With the spectrograph, Slipher has been able to measure the rotational speeds of two or three spirals, including the great spiral in Andromeda, and Pease has repeated and extended the experiment on one of them. The rotational speeds are also extremely rapid, as indeed one should expect from the tremendous inequalities in what we venture to call their equatorial and polar diameters. Assuming that Newton's law of gravitation controls their rotations, the probable masses are stupendous. Some of them seem to contain enough material to make tens of thousands, probably hundreds of thousands, and possibly millions, of stars comparable in mass with our own sun.

The spectra of only a few of the brighter spirals have thus far been investigated in any degree of adequacy, but they have the characteristics which we should expect to find if the spirals consist chiefly of multitudes of stars. I say chiefly, because in the spectra of some of them we find the bright-line spectrum of gaseous nebulæ superposed upon what we may call the stellar type of spectrum.

If we carried our spectrograph so far out into space that, looking back, our stellar system would be reduced down to the apparent size of the well-known spiral nebulæ, and we turned the instrument upon our condensed system, we should expect to see a spectrum very like the continuous and absorption line spectra yielded by the spirals; and certain structures in our system, such as the region containing the Orion nebula, might well yield the bright nebular lines found in some parts of certain spirals. Curtis has recently examined the spectra of fifty of the brighter small nebulæ lying within 25° of the Galaxy which had not been subjected earlier to spectroscopic test. None of them showed bright lines; all appeared to be of the stellar or cluster type of spectrum. An extension of the survey to the pole of the Galaxy would probably have had similar results.

We are not able to resolve the spirals into stars except as we seem to be ap-

FIG. 21. The Spiral Nebula, Messier 33, photographed by Keeler with the Crossley Reflector of the Lick Observatory.

proaching resolution in certain parts of one great spiral, Messier 33, in the constellation of Triangulum (Fig. 21). That one is probably relatively near us, but of that we are not sure. Some astronomers who have photographed the Magellanic clouds (see Figs. 22 and 23), in the far southern sky, say that these remarkable objects are spiral in structure. If so, they are spirals easily resolved into stars. Nevertheless, these clouds are enormously distant. Hertzsprung has estimated, from certain considerations, that the distance of the Lesser Cloud is of the order of 30,000 light-years. Wilson has measured the spectroscopic velocities of approach and recession of twelve nebulæ in the Greater Cloud, and has found that they are receding with speeds lying between 150 and 200 miles per second. The velocities of the twelve objects differ from each other as many miles per second as we should expect to find for twelve bright-line nebulæ selected at random in our galactic system, but the average for the twelve in the Cloud shows an abnormally high rate of recession. All of the known bright-line nebulæ in that great region of the sky are in the two Clouds. None is known to exist outside of the Clouds until we have gone far from them in the direction of the Milky Way (see Fig. 11). There are still other reasons for the unquestioned conviction

that these nebulæ are actually a part of the structure of the Clouds. It is difficult to avoid the conclusion that the observed speed of recession of the twelve nebulæ within the

Fig. 22. The Greater Magellanic Cloud, photographed by Bailey, at the Arequipa, Peru, station of the Harvard College Observatory.

Greater Cloud, averaging 175 miles per second, is the approximate speed of recession of the Greater Cloud. Motions of this magnitude have not been observed for any objects known to be within our stellar system, except in the case of three or four individual small stars. We can not seriously doubt that the Magellanic Clouds are distinct from and independent of our great stellar system; and, if they are of spiral structure, they are spirals relatively near to us, as the distances of spirals go.

Seares has recently discovered an interesting peculiarity of spiral nebula, at least of the four or five thus far studied, by means of photographs of spirals, with exposures first on ordinary plates sensitive to the blue-violet rays, and secondly on isochromatic plates and through screens which transmit only the yellow-green rays. The results, illustrated in Fig. 24, show that the light from the outer arms of the spirals is richer in the blue and violet rays than is the light from the central nuclei. The significance of these facts is not yet clear.

We can not say that the problem of interpreting the spiral nebulæ has been solved. In fact, it is a fair statement that our positive knowledge as to the conditions existing within them is regretfully meager. *We are not certain how far away they are; we are not certain what they are.* However, the hypothesis that they are enormously distant bodies, that they are independent systems in different degrees of development, is the one which seems to be in best harmony with known facts. It should be said that this hypothesis is a very old one. Swedenborg speculated upon the idea that our stellar system is but one of a great number of systems. The serious consideration of the hypothesis, upon the basis of observed facts, may be said to date from the two Herschels. Following Keeler's epoch-making observations of nebulæ in 1898–1900, many astronomers have studied the subject.

We naturally ask why it is that certain globular star clusters are visible not far to one side or the other of the Milky Way, whereas the spirals there are faint and

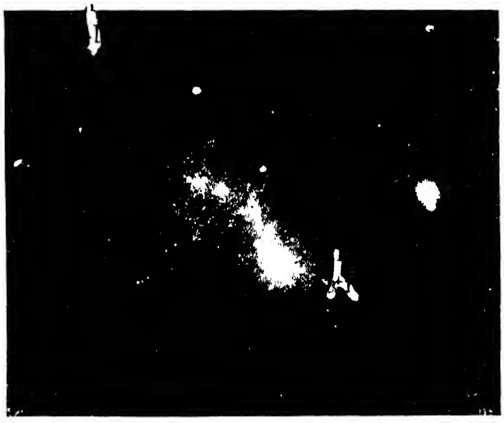
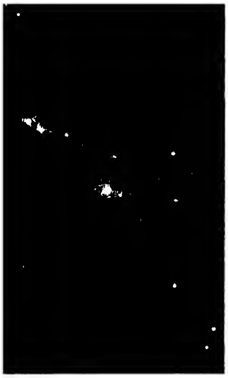
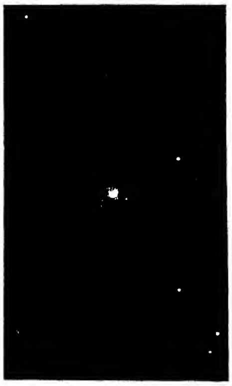


Fig. 23. The Lesser Magellanic Cloud, photographed by Bailey, at the Arequipa, Peru, station of the Harvard College Observatory.





Seed 27, 20 min. Iso, 2 hours.

FIG. 24. The Spiral Nebula, Messier 99, photographed without and with absorbing color screen, by Seares with the 60-inch reflecting telescope of the Mount Wilson Solar Observatory.

scarce. No one has given a satisfactory answer to this unless it be correct to say that these great globular clusters of stars, though extremely distant, are yet near at hand in comparison with the distances of the spirals. Ritchey's photograph of the great cluster in Hercules (Fig. 25) records fully 30,000 stars, and these are undoubtedly only the more brilliant members of the cluster. Still longer exposures might record 100,000 stars and yet leave unrecorded the fainter members of the cluster in vastly greater numbers. Shapley estimates the distance of this cluster, from several lines of investigation, as of the order of 100,000 light-years. Other great clusters have not been so thoroughly studied, but the available evidence concerning them is in harmony with the hypothesis of their great distances. Our own universe may be enormously more extensive than we see it because the outer stretches of it may be hidden by obstructing materials. If the obstructing materials consist chiefly of discrete particles whose diameters are large in comparison with the wave-lengths of light, we should expect the obstruction to be such as to reduce the brightness of distant objects without changing seriously the quality of their light.

The most elaborate structure yet proposed to explain the origin and development of the solar system is the planetesimal hypothesis by Chamberlin and Moulton. They postulate that the materials now composing the sun, planets and satellites, at one time existed as a spiral nebula, or as a great spiral swarm of discrete particles, each particle in elliptic motion about a central nucleus. The authors go further back and endeavor to account for the origin of spiral nebulæ, but it should be said that this phase of the subject is not vital to their hypothesis. It will happen once in a while, they say, that two massive stars will approach and pass each other closely. These stars will raise great tidal waves upon each other by their mutual attractions, and there will be outbursts of matter from each body, not only on that side of each which faces the other body, but on the opposite side of each, for somewhat the same reason that tidal waves in our oceans are raised on the side opposite the moon as well as on the side toward the moon. They assume that a great star traveling in what is now the principal plane of our solar system passed close to our sun when it was in an earlier stage of its existence; that a resulting disruption of

our sun led to the drawing out of solar materials in two opposing spiral branches; and that these materials in part, or for the most part, remained outside of the sun and in revolution about it, the whole composing a spiral nebula. The materials in the two branches of the spiral, the authors say, eventually combined into certain central

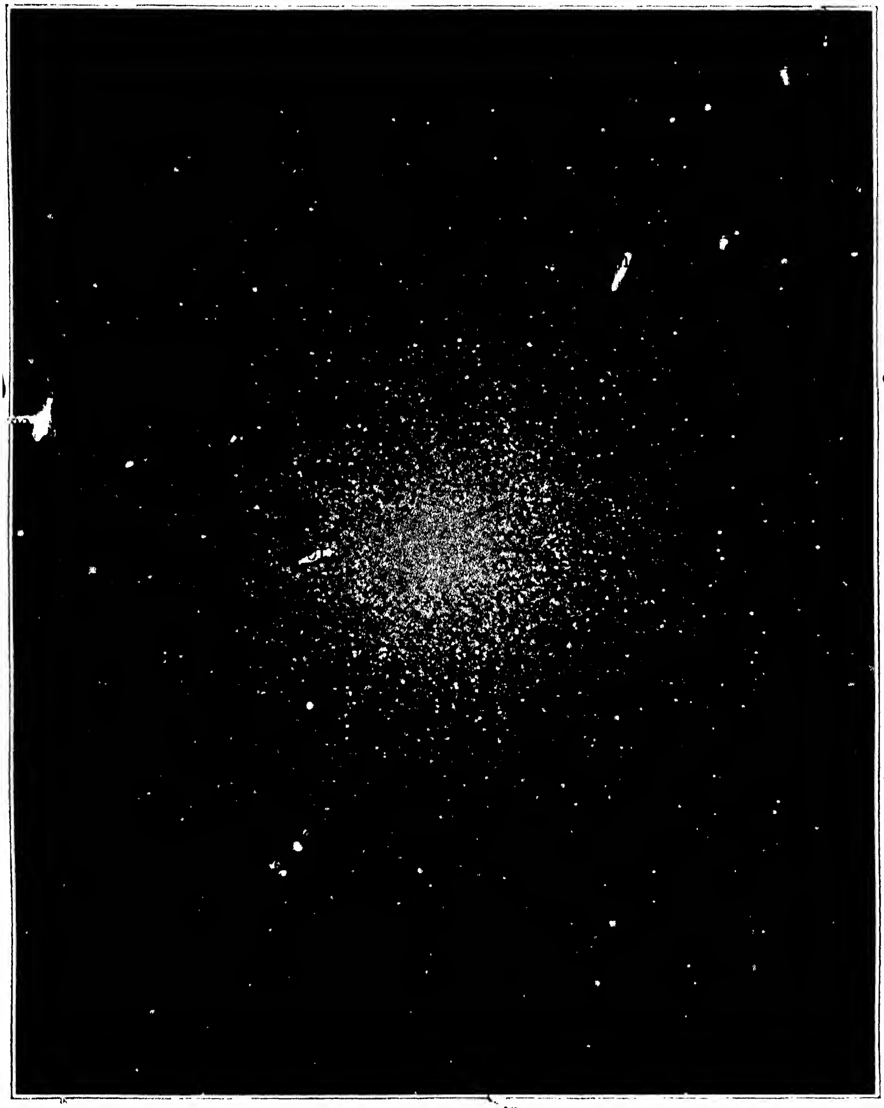


FIG. 25. The Great Star Cluster in Hercules, photographed by Ritchey with the 60-inch reflecting telescope of the Mount Wilson Solar Observatory.

FIG. 26*a*. Planetary Nebula N.G.C. 7009. Composite drawing by Curtis from photographs made with the Crossley Reflector of the Lick Observatory. With the slit of a 3-prism spectrograph placed on the longer axis, the bright nebular lines were found to be inclined to the direction of the slit, owing to the rotation of the nebula, as shown (exaggerated) in the upper part of this figure, and as reproduced from the spectrogram in Fig. 26*b*.

masses, in accordance with the simple laws of physics, and the planets and their satellites of our system, as they exist to-day, are the result.

I see no reason to question that a spiral nebula could originate in this manner: the close passage of two massive stars could, in my opinion, produce an effect resembling a spiral nebula, quite in accordance with Moulton's test calculations on the subject. Some of the spirals have possibly been formed in this way; but that the tens of thousands of spirals have actually been produced in this manner is another question, and one which, in my opinion, is open to grave doubt. The distribution of the spirals seems to me to negative the idea. If the close approaches of pairs of stars are producing the spirals we should expect the spirals to occur and to exist preëminently in and near the Milky Way structure, for that is where the stars are; and this is precisely where we do not find the spirals.

I think it is more probable that our stellar system as a whole is a spiral nebula, or has analogies to a spiral nebula, and that our solar system has been formed from an insignificant detail of spiral structure, than that our sun and its system of planets and moons should be the evolved product of an entire spiral nebula. Of course we have not

FIG. 26*b*. The First (right) and Second (left) Green Lines of Nebulium in the Spectrum of N.G.C. 7009.

[Enlargement approximately 20-fold. The six lines at the upper and lower edges of the figure are the reference spectrum of titanium.]

the proof of this; but the chances would appear to be strong that the ancestor of our solar system was a mass, nebulous or otherwise, comparatively diminutive in size.

There seems to be no reason to doubt the value of Herschel's opinion that a planetary nebula will develop into a star. Laplace's hypothesis that our solar system has

Fig. 27. Visual Image (right end) and Part of Visual Spectrum (left end) of the Planetary Nebula N.G.C. 418.

[The horizontal line in the left half of the figure is a part of the continuous spectrum of the stellar nucleus of the nebula at the right end. Of the three white circles in the spectrum the left one is the hydrogen Beta image of the nebula 14 sec. of arc in diameter, the middle circle is the "second nebulium" green image of the nebula 9 sec. of arc in diameter; and the right one is the "first nebulium" green image of the nebula, 11 sec. of arc in diameter.]

developed from a small rotating nebula is still exceedingly valuable, but it has been so buffeted by the winds and waves of criticism that many of the details have had to be thrown overboard. I think we should give ourselves some assurance that certain of the planetary nebulæ may develop into systems bearing many resemblances to our solar system. Campbell and Moore have been able in the past year and a half to prove, by means of the spectrograph (see Figs. 26*a* and 26*b*), that these bodies are in rotation—just as we should expect them to be from their more or less symmetrical forms—around axes passing through their centers; these axes, in general, at right angles to their longest dimensions. The rotation of our sun and the revolution of our planets about the sun, all in one and the same direction and very nearly in the principal plane of the system,[1] afford a close analogy.

The rotational velocities of the gases composing the principal rings in the planetary nebulæ are comparable with the orbital speeds of our great planets, Jupiter, Saturn, Uranus and Neptune; and the rotational speeds of the gases are slower and slower as we go out from the principal rings, which is true of the orbital speeds of the planets of our system.

It appears that there is very little material between the stellar nuclei and the principal rings of the planetaries. The material which we should normally expect to find there has apparently been drawn into the central stars. Very little material is left in that space to condense into planets, just as in our solar system the four inner planets, Mercury, Venus, earth and Mars, and the many asteroids, are of almost negligible mass. Jupiter and the other three outer planets contain 225 times as much matter as the earth and the other three inner planets and the more than 800 asteroids.

If we assume that the rotational speeds of the particles composing the rings and other outer structure of the planetary nebulæ are controlled by Newton's law of gravitation, we have means of estimating the masses of their central nuclei, or stars. The indications are extremely strong that the planetary nebulæ are in general at least as massive as our solar system: many times as massive in some cases, possibly less massive in others. In them we seem to have enough materials to develop into systems comparable in mass with our solar system.

More than twenty years ago I observed that the different gases composing several of the nebulæ are not uniformly distributed throughout the nebular structure. The hydrogen in some of the nebulæ that were

FIG. 28. The Spectrum of the Planetary Nebula N.G.C. 7662, photographed by Wright with the Draper slitless quartz spectrograph and the Crossley reflecting telescope of the Lick Observatory.
[The images of the nebula given by the radiations of different elements and different wave-lengths show a great variety of diameters and structural details. The two ellipses at the extreme right, strongly overlapping, are the two green nebulium images of the nebula. The adjoining smaller ellipse, slightly overlapping, is the hydrogen Beta image. The small images at the left end of the figure are far out in the ultra-violet region of the spectrum.]

critically examined was found to extend out farther than do the other chemical elements. Such was the case in the great Orion nebula, in the Trifid nebula, and in one of the small planetaries, N. G. C., 418. Viewed in the telescope, the latter was observed to be a disc of greenish-blue light, about fourteen seconds of arc in diameter, with a well-defined star near the center of the disc. Viewed in the spectroscope, the spectrum of the central star was a continuous line of light, and the composite disc was resolved into three separate discs (see Fig. 27); the largest one of hydrogen, fourteen seconds of arc in diameter; a smaller one, corresponding to the first green line of the element nebulium, eleven seconds of arc in diameter; and a still smaller one, corresponding to the second line of nebulium, nine seconds of arc in diameter. The nebulium did not extend out so far from the central star as the hydrogen. Wolf and Burns applied photographic methods to a similar study of the Ring Nebula in Lyra, in 1908 and 1910, respectively, and found differences both in the sizes and in the detailed structure of the spectral rings. Wright has in the past two years carried the development of the subject much further, by photographic methods applied to the principal planetary nebulæ (see Fig. 28). He finds, for example, that the distribution of the helium in the structure of the planetary nebulæ always favors the central nucleus or star more than the hydrogen and nebulium distribution do. In some of the planetaries, the helium has apparently been drawn entirely into the central nucleus. In one of the planetaries the hydrogen globes seem to persist brilliantly after the nebulium images have become reduced in size, or have become exceedingly faint. We can scarcely doubt that in these phenomena we are witnessing certain stages of progress in the gradual evolution of the planetary nebulæ into the stars which we see at their centers, or, possibly, into systems of stars and planets. The materials, for the most part, seem to have been drawn—possibly are still moving—into the central stars, into suns that are forming; and a very little of the materials shown by observation to be revolving around the central suns may ultimately be left to form planets of the systems. Let us recall that in our own solar system 99 6/7 per cent. of the materials are in the sun, and that only one seventh of one per cent. of the materials exists outside of the sun, in the eight major planets and their moons.

The different sizes of the elliptic images of different chemical elements in the spectrum of a planetary nebula give some basis for the speculative thought that the chemical composition of the large outer planets of our solar system may be quite different from that of the small inner planets.

While a strong case can be made out for

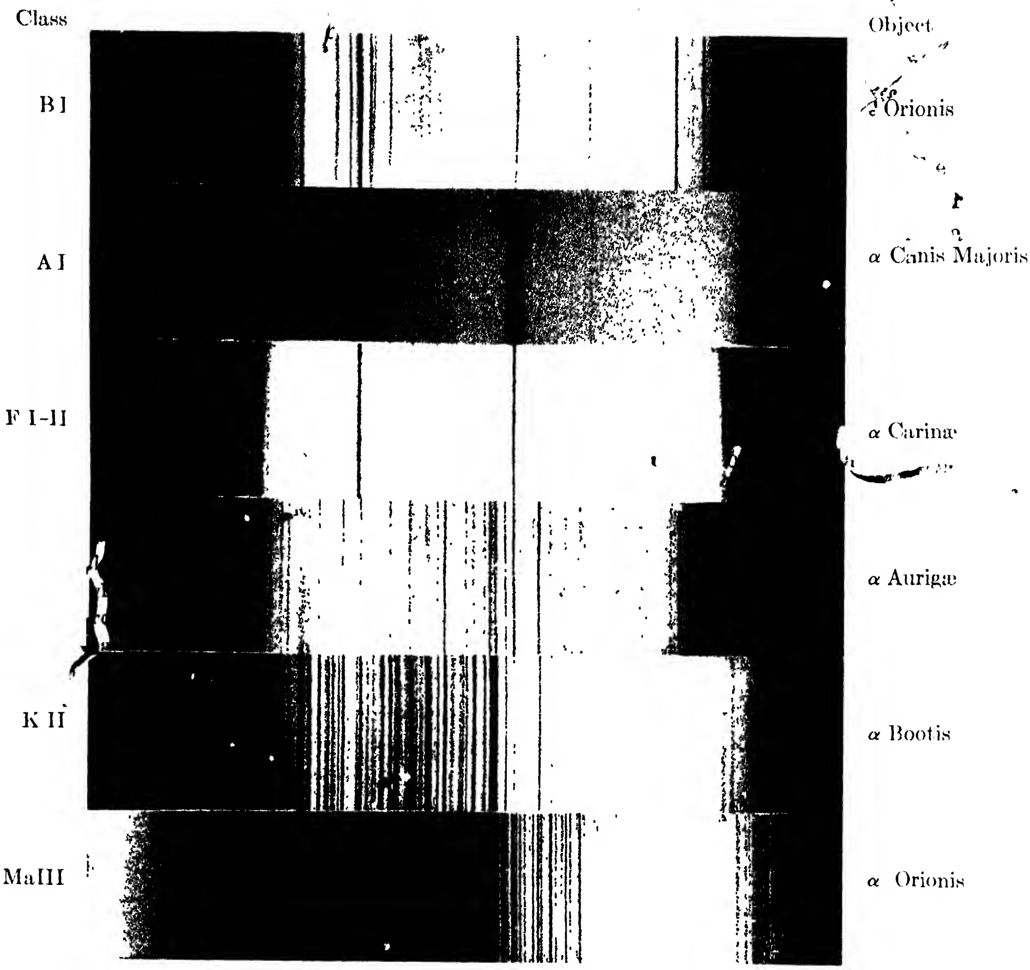


Fig. 29. Types of Stellar Spectra, Henry Draper Memorial, Harvard College Observatory.

the evolution of planetary nebulæ into stars at their centers, with possible planets revolving around them, we must not conclude that all stars have been formed from planetary nebulæ. There are reasons for rejecting that view.

1. Amongst the many millions of stars whose images have been examined in the telescopes or on photographic plates, fewer than 150 planetary nebulæ have been found. Unless the planetary-nebula stage of existence is lived very rapidly, the numbers are too few to play a controlling part in the development of stars in general at any point in stellar evolution.

2. The average speeds of the planetary nebulæ and of the different classes of stars are now fairly well defined. The average speed of the planetary nebulæ is about seven times that of the extremely blue stars, which are the only ones, we shall see later, that we need consider as the immediate descendants of the nebulæ. There are indeed individual stars which are traveling as rapidly as the individual planetary nebulæ, but on the average the discrepancy

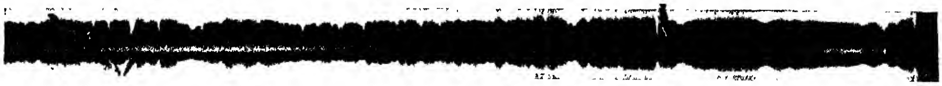


FIG. 30. The Spectrum of Alcyone, photographed by Wright with the Mills Spectrograph of the Lick Observatory.

[The star spectrum occupies the central horizontal section. The bright hydrogen Alpha line is one fourth inch from the right end, and the dark hydrogen Beta line is one half inch from the left end.]

seems entirely too great to let us conclude that the blue stars in general could have been formed from planetary nebulæ such as the 150 planetaries now known to us.

For the hypothesis that the stars in general have evolved from irregular nebulæ a vastly stronger case can be made.

In a priceless possession of astronomy, the Draper catalogue of stellar spectra, Harvard College Observatory has classified the spectra of a great many thousands of the brighter stars. They have been arranged in a sequence, running from the so-called extremely blue stars through the yellow stars to the red stars, which can be readily described. The main divisions are illustrated in Fig. 29. Each main class has ten subdivisions, but we need not dwell upon details. The dark lines in these spectra indicate the presence of certain vapors and gases of the chemical elements in the outer strata of the stars. In the Class *B* stars the helium lines rise to their maximum strength near the middle of the *B* subgroups and sink to insignificance in the later *B* or earlier *A* subdivisions, and the helium lines are not found at all in Class *F* and the later types. The hydrogen lines are fairly prominent in the Class *B* stars, but they increase to maximum intensity in Class *A*, and then decrease continuously throughout the remaining groups. The hydrogen lines are very inconspicuous in Class *M*, or red stars. The magnesium lines go up to a maximum in Class *A* and down to disappearance in the *F*'s and *G*'s. Some of the metallic lines, such as titanium and iron, usually begin to show in the later subdivisions of Class *A*, other metallic lines first enter upon the scene in Class *F*, and they increase in numbers and prominence up to a maximum in the red stars. The calcium lines are weak or entirely wanting in the Class *B*'s, and they increase in intensity as we pass down through the series, until they become the most prominent features in the spectra. We can not change the arrangement of these spectral classes without throwing the sequence of development of the spectral lines into hopeless disorder. This sequence is thought to represent the order of stellar evolution. A Class *B* star, according to that hypothesis, is a comparatively young star. It should develop, in the course of long ages, into an *F*, a *G*, a *K*, an *M*, and so on, to its final destination of darkness and invisibility.

Some of the Class *B* stars contain bright lines of hydrogen. Alcyone (Fig. 30) and Pleione, in the Pleiades, contain both bright

FIG. 31. The Spectrum of Eta Carinæ, photographed by Moore at the D. O. Mills Observatory Santiago, Chile.

[The series of bright lines above and below the star spectrum are the reference spectrum of iron.]

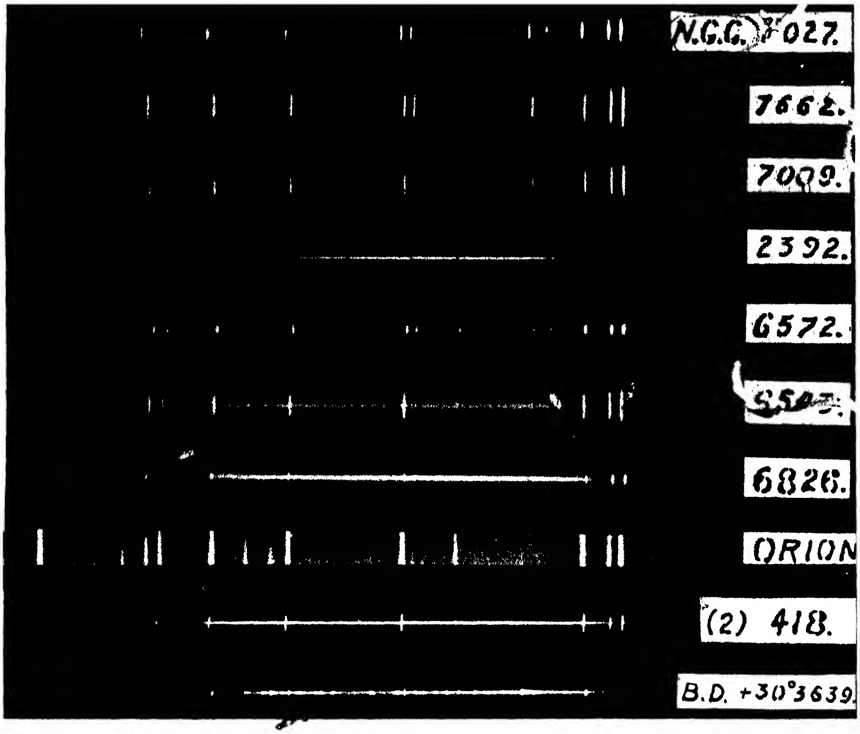


Fig. 32. Representative Spectra of Bright-line Nebulæ, photographed by Wright with the Mills spectrograph and 36-inch refracting telescope of the Lick Observatory.

and dark lines of hydrogen. There are hundreds of stars whose spectra contain a wide variety of bright lines and dark lines. Now and then a star's spectrum consists almost wholly of bright lines, as in the case of Eta Carinæ (Fig. 31). The bright lines in stellar spectra tell us that their stars contain extremely extensive atmospheres of the gases and vapors hydrogen, helium, and so on. A close relationship exists between the Class *B* stars, with and without bright lines, and a class of stars found extensively in the Milky Way structure whose spectra, containing many bright lines, are known as Wolf-Rayet spectra, after the discoverers of the first few stars in the class. Now, as Wright has shown, the central stars in the planetary nebulæ are of the Wolf-Rayet type (see Fig. 32, B.D + 30° 3639) in nearly all cases, and in other cases their spectra are closely related to Class *B* spectra (see Fig. 32, N.G.C. 2932). It has been snown, also chiefly by Wright, that the spectra of the nebulous parts of the planetary nebulæ have many points of connection with the spectra of the central stars. The spectra of the planetary nebulæ and the spectra of those large extended nebulæ (see Fig. 32, Orion, etc.) which give bright lines are essentially alike in character. The nebulium lines of the nebulæ have never been found to exist in any true star, no matter what its class, and we leave them out of account in this discussion; they do not in-

fluence our present question one way or the other. Aside from nebulium, the hydrogen and helium lines are the most prominent ones in the bright-line nebulæ. They are the most prominent ones in the nuclei of the planetary nebulæ. They are prominent in the isolated Wolf-Rayet stars, in the Class *B* stars containing bright lines, and in the

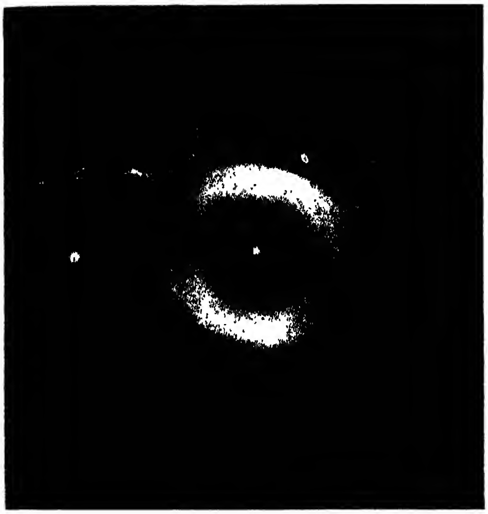


FIG. 33. The Ring Nebula in Lyra, photographed by Curtis with the Crossley Reflector of the Lick Observatory.

Class *B* stars containing only dark lines. Helium has never been found in any yellow or red stars, except feebly in a certain stratum of our sun's atmosphere, and that is due to our ability to observe our sun somewhat in detail; and the hydrogen is relatively feeble in the later classes of the Harvard sequence.

The continuous spectra of stars as arranged in the Harvard sequence decrease continuously in the relative strength of the blue, violet and ultra-violet regions as we pass from the central stars of the planetary nebulæ, which are wonderfully strong in ultra-violet light, down through the blue stars with both bright and dark lines, through the blue stars[6] containing dark lines only, and on through the yellow stars to the red stars. The central star in the ring nebula in Lyra (Fig. 33) is invisible to many inexperienced observers, even in the great Lick telescope. Yet it is so rich in violet light, and especially in ultra-violet light, that it can be photographed in the great reflecting telescopes with an exposure of only two or three seconds. Wright has recently made the interesting discovery that the continuous spectra of many planetary nebulæ are remarkably strong in a long stretch of the ultra-violet region. The sequence of decreasing richness in blue and violet light extends unbroken from the nebulæ and nebular nuclei down to the red stars.

The spectra of the stars are indicative of conditions existing in their surface strata. We do not know definitely just w[illegible] conditions produce or accompany certain types of spectra, but surface temperature seems to be a prime influence, and there are some reasons for thinking that electrical conditions may also be extremely important. Now all determinations of the surface temperatures of the stars make the extreme blue-violet stars the hottest of all, with the effective temperatures decreasing continuously as we pass from the nuclear stars of the planetary nebulæ down through the Harvard sequence to the red stars. Fabry and his associates in Marseilles have recently arrived at the result, by physical methods, that the temperature of the Orion nebula is very high, vastly higher than the temperatures of the red and yellow stars,

[6] Huggins has called attention to a reduction in the brightness of the ultra-violet spectrum of the first-magnitude star Vega (Class *A*) by virtue of what seems to be an absorption band many hundred Angstrom units in width. It is not yet known to what extent the ultra-violet spectra of blue stars in general may be affected by such an absorption band.

and comparable with the temperatures of the blue stars. There again is a sequence with the nebulæ and the blue stars at one end and the red stars at the other.

Fowler has called attention to the remarkable facts that certain lines of helium, etc., requiring the most powerful electric discharges at command to produce them in the laboratory—super-spark lines, he calls them—are found in the greatest relative strength in the gaseous nebulæ; next in order of strength in the bright-line or Wolf-Rayet stars, which class includes the central stars of the planetary nebulæ; and in lesser strength in the first subdivision of the Class *B* stars, that is, in the bluest of the blue stars containing dark lines only; secondly, that the lines in the spectra of the later Class *B* stars, of the Class *A* and Class *F* stars are prevailingly those produced under the less intense conditions of the ordinary electric spark; and, thirdly, that the lines in the yellow-red stars are prevailingly the arc lines which indicate relatively weak electrical conditions. That is another sequence of conditions running from the nebulæ down to the red stars.

There are still other sequences running harmoniously through the Harvard classification. For example, the velocities of the stars in their travels within the stellar system increase as we pass by spectral classes from the large bright-line nebulæ and the very blue stars down through the yellow stars to the red stars. The distances apart of the two components of double stars, and consequently their periods of revolution around each other, increase consecutively as we pass from the blue stars to the red.

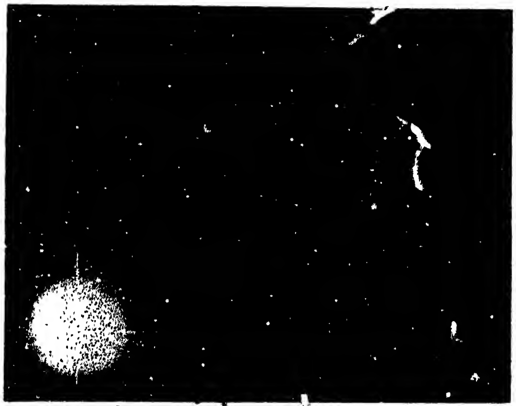


Fig. 34. The Irregular Nebulæ near Gamma Cassiopeiæ, photographed by Curtis with the Crossley Reflector of the Lick Observatory.

[The immensely over-exposed image of the brilliant star Gamma Cassiopeiæ is at the lower left-hand corner. The lines radiating from the center of the star image are diffraction effects produced within the telescope. The upper right half of the figure contains much nebulosity, the brighter angles of two nebular structures pointing approximately toward the star Gamma.]

It might be said that, so far as all these stellar sequences are concerned, the course of evolution could begin with either the red stars or the blue stars and proceed to the other end of the sequence. Not to mention several very weighty objections to the assumption that the red stars are effectively young and the blue stars effectively old, we submit the case on the evidence of the nebulæ. The planetary nebulæ, the irregular nebulæ, the Wolf-Rayet stars, the Class *B* stars with bright lines, and the Class *B*

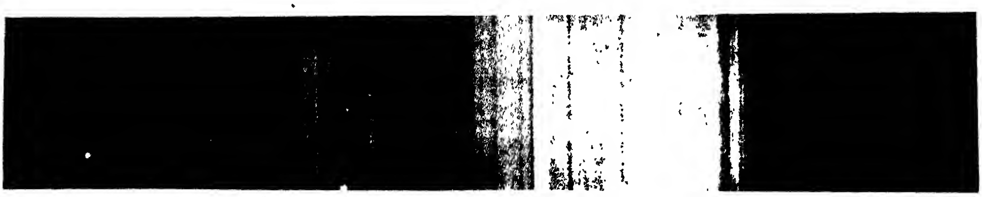


Fig. 35. The Spectrum of Gamma Cassiopeiæ, Henry Draper Memorial, Harvard College Observatory.

stars with dark lines are found prevailingly in and near the Galaxy. Pickering's study of the distribution of 6,106 of the brightest stars is summarized in the accompanying table.

GALACTIC LATITUDES OF STARS BRIGHTER THAN 6.25

Average Latitude	*B*	*A*	*F*	*G*	*K*	*M*	All
+ 62°.3.....	8	189	79	61	176	56	569
+ 41°.3.....	28	184	58	69	174	49	562
+ 21°.0.....	69	263	83	70	212	57	754
+ 9°.2.....	206	323	96	99	266	77	1,067
− 7°.0.....	161	382	116	84	239	45	1,027
− 22°.2.....	158	276	117	100	247	69	967
− 38°.2.....	57	1[illegible]1	94	59	203	59	633
− 62°.3.....	29	1[illegible]7	77	67	202	45	527
Sums.......	717	1,885	720	609	1,71[illegible]	457	6,106
Means......	90	236	90	76	2[illegible]5	57	763

The sky is divided into eight zones of equal areas, with the boundaries of the zones parallel to the galactic plane. The first line of figures contains the numbers of stars of the different spectral classes in the one eighth of the sky around the north pole of the Galaxy; the fourth and fifth lines the numbers in the zones containing the Galaxy, one zone adjoining the Milky Way on the north and the other on the south; and the last line the numbers of stars of the different classes in the eighth of the sky around the south pole of the Galaxy. If the stars of the different classes were uniformly distributed over the sky, the eight numbers in each vertical column would be equal. It is seen that the Class *B* stars are prevailingly in the Milky Way, and that the red stars of Class *M* are about uniformly distributed over the sky, though they are all in our stellar system.

The Class *B* stars and the stars containing bright lines are where the planetary and irregular nebulæ exist. Going further into detail: wherever there is a great nebulous region either in, or near, or outside of the Milky Way you will find the Class *B* and earlier types of stars abnormally plentiful; and the chances are fairly strong that some of the stellar spectra will contain bright lines. This is true of great regions in the Milky Way, it is true of the Orion and Pleiades regions, which we see at some distance outside of the Milky Way structure, though they are doubtless within our system. If you see a wisp of nebulosity near a bright star, look up the star's spectrum and you will probably find it an early Class *B*, as in the case of Gamma Cassiopeiæ, a second magnitude star, with nebulous structure near it (Fig. 34), whose spectrum contains both bright and dark lines of hydrogen and helium (Fig. 35). If you see an isolated bright star apparently enmeshed in an isolated patch of nebulosity, such as the one shown in Fig. 37, and the books say the star (*BD*−10°-4713) is yellow, or of Class *G*, communicate your suspicions that the books are mistaken about that star's spectrum to Professor Pickering, and he will probably reply that the star is in reality a very blue one, of early Class *B*. That is what happened a fortnight ago about this particular nebula and the star near its apparent center. If you find a red or yellow star of normal type, do not look for a nebula in apparent contact with it. Nebulæ and red stars do not coexist. You will find about the same number of red stars in the Milky Way that are visible in similar areas far from the Milky Way. You will find an occasional red star in the region of the Orion nebula and of other large nebulæ, but red stars will not appear there in greater numbers than their approximately uniform distribution over the sky requires.

The connection between the nebulæ and the bright-line stars, and between the nebulæ and the early Class *B* stars is close, both as to their types of spectra and as to their geometric distribution.

Do the nebulæ form stars or do the stars form nebulæ, or both? There is abundant

evidence that the catastrophes which produce new or temporary stars produce temporary nebulæ, for at a certain stage of their existence the temporary stars have nebular spectra; but in all cases thus far observed—as Adams has shown—the nebular spectrum quickly transforms itself into the Wolf-Rayet stellar spectrum. It is not impossible that the planetary nebulæ have in some cases resulted from the more violent catastrophes of distant space and time; that bodies originally stars may have been expanded under the heat of collision or other catastrophe to nebular conditions; but that an ultimate condensation will transform such nebulæ again into the stellar state, we can not doubt. That such nebulæ as those in the Pleiades (Fig. 13) or as the great Net-Work nebula in Cygnus (Fig. 36) were formed from stars can not be regarded with favor for a moment; but that the many Class B stars existing in those regions should have been formed from nebulous matter, and that others may be forming, implies an evolutionary process that is both natural and easy of comprehension. Transformation from star to nebula is abnormal, is *revolution*, under the influence of catastrophe. Transformation from nebula to star is normal, is *evolution*, under the continuous and regular operation of the simple laws of physics.

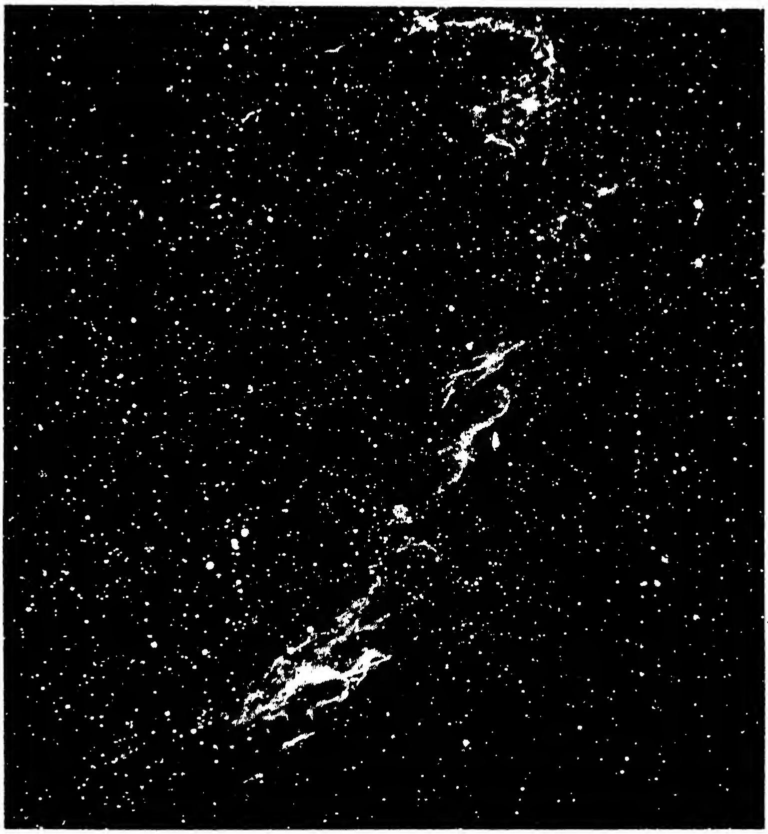


FIG. 36. The Net-work Nebula in Cygnus, photographed by Keeler with the Crossley Reflector of the Lick Observatory.

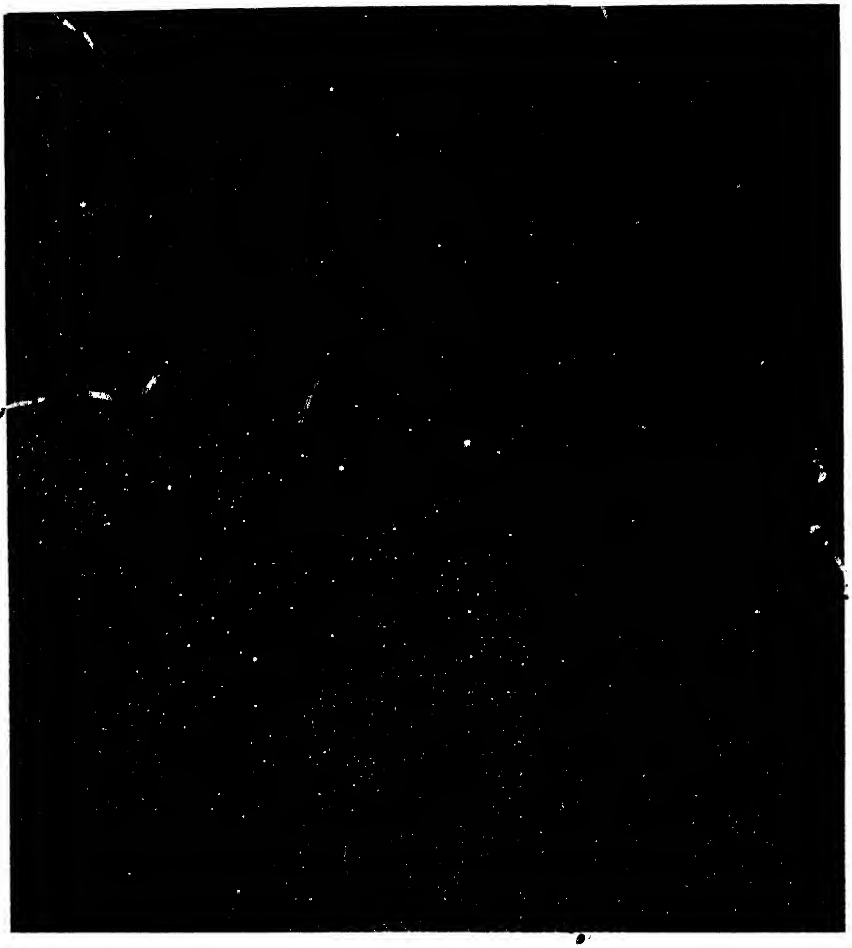


FIG. 37. The Milky Way, photographed by Barnard with the Bruce 10 inch telescope of the Yerkes Observatory.

[Of special interest is a small isolated nebula with a fifth magnitude star, BD — 10° 4713, near its center; nebula and star in the region poor in stars near the center of the photograph.]

Those who would suggest that the red stars[7] may be the young stars must start with stars uniformly distributed over the sky, and unassociated with nebulosity; and, transforming them through and past the red and yellow stages, must carry them prevailingly into the galactic regions, where, as Class *B*, or extremely blue stars, they

[7] This does not include the extremely red (Harvard Class *N*) stars. We refer to the 457 naked-eye red stars of Class *M* in Pickering's table, page 507, which are prevailingly the more massive members of their spectral class.

preferentially collect in the great nebulous areas, or, in many cases, become enmeshed in details of nebulous structure. We should pause long and consider well before embarking upon a voyage in that direction.

Long centuries of ignorance as to our surroundings gave way, finally, to the enlightening influence of the discovery of the place of the continents upon the earth, and of the place of our planet with respect to the sun. Working at peace and under extreme encouragement, the astronomers of to-day are learning the place of our star and its planets amongst the other stars. If the Magellanic Clouds, the greater globular star clusters, and the spiral nebulæ prove to be separate and independent systems, we shall bequeath to our successors the mighty problem of finding the place of our great stellar system amongst the host of stellar systems which stretch out through endless space.

Lick Observatory,
University of California

SCIENCE

FRIDAY, JUNE 1, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE FUNCTION OF MATHEMATICS IN SCIENTIFIC RESEARCH[1]

MATHEMATICS embodies some of the earliest scientific developments and hence she was practically unrestricted in regard to the selection of her location in what became later the domain of science. Did she select for herself the most fertile available land or was she misled by superficial attractions in making her choice, while the richest mines were hidden under other land whose surface presented fewer attractions and whose development demanded more complicated machinery? One might naturally expect different answers to this question from the members representing the varied interests of this Science Club.

It is not our purpose to extol the advantages of location with respect to the mathematical mine. This location was pointed out to you in your youth and the impressions which it has left on your minds are too deep to be modified materially by a few general remarks. Moreover, some of the tunnels of the mathematical mine are used daily by many of you, who gladly speed through them for the purpose of saving time to employ your energies more effectively in the field of your own choice.

Notwithstanding these facts, all will agree that the mathematical mine has been developed extensively, and that its developments have been most helpful and are becoming more useful to various other sciences. As the rivers excavated unknowingly for possible railroad lines through the mountains

[1] Read before the Science Club of the University of Wisconsin, April 5, 1917.

long before the construction of such lines was undertaken, so mathematics has been preparing thought roads for sciences long before their development was seriously begun. Hence it does not appear inappropriate for a body of scientists to pause now and then for a few moments to reflect on the methods and ideals which have actuated the mathematical investigator. Such reflections may be inspired by a sense of respect for all that contributes to scientific progress, but they should also prove helpful in the formation of most comprehensive notions in regard to the great problems which confront us as a united band of workers to secure light, to dispel more of the superstitions and to present far-reaching thoughts in the simplest manner.

Among the questions which scientists as a body might be inclined to ask the mathematician is the following: What is the attitude of mind which has contributed most powerfully to mathematical progress? Such a profound question would naturally be answered somewhat differently by different men, and your speaker to-night is not so completely ignorant of his own limitations as to suppose that he can furnish a final answer to this question. He hopes, however, that he may not be entirely unsuccessful in making some illuminating remarks on it, and in interesting you by directing your attention to common thoughts which underlie the varied efforts by which we as a body aim to enrich the world.

With this reservation I would be inclined to say that *modesty* is the attitude of mind which has contributed most powerfully to mathematical progress. The great "Elements" of Euclid, for instance, are candidly based on assumptions or axioms and do not claim to prove everything *ab initio*. Moreover, this great work does not concern itself directly with such fundamental questions as truth, reality, life, death, etc., but it confines itself to deductions relating to matters which might appear as trivialities when compared with many other problems which then confronted and now confront the human race.

To understand the modesty of Euclid and his geometric predecessors it is necessary to bear in mind the fact that the "Elements" of Euclid were written at a time when other sciences made little or no demand for such results as these "Elements" embodied. Even such a closely related subject as surveying could then make little direct use of these results in view of the theoretic form in which they were presented. The work which is said to have passed through more editions than any other book except the Bible, which considers diametrically opposite questions, must have appeared to many of Euclid's contemporaries as dealing with comparatively trivial matters in a modest way, since it made no attempt to trace its fundamental principles to their sources, but explicitly started with axioms or postulates.

As another evidence of modesty in mathematics I may mention the special symbols for unknowns and the use of equations in these unknowns. The scientific method embodied in equations involving at least one unknown implies the careful study of relations involving something with respect to which we have openly acknowledged our ignorance. Like the axioms or postulates of geometry, it makes no pretention of complete knowledge, but is satisfied with an humble attitude of mind. The basis of mathematical development is thus seen to be characterized by a modesty which has led the investigator to do what he can do thoroughly rather than to try to do that which would naturally interest him more but which lies beyond his power.

Even in its most primitive form, count-

ing, mathematics clearly dealt with matters of secondary importance. Is not the finger more important than the number attached to it in view of its position in relation to the other fingers? Why should the primitive races then have turned their thoughts away from the most important to matters of secondary importance? As I understand it, this turning away from unfathomable but most enticing difficulties to the fathomable but less enticing ones is the great keynote of science, and mathematics was perhaps the first scientific subject to sound this keynote with decided clearness. It was, however, not always sounded with clearness by mathematicians. The Pythagoreans, for instance, endeavored to make it appear that numbers were endowed with noble properties which are entirely foreign to them. They were not yet sufficiently modest to study mathematics most effectively, and their spirit has its representatives even in our day.

The picture representing the attitude of mind which contributed most powerfully to mathematical investigation would, however, not be complete without uniting with modesty discretion and a love for mental travel and exploration. The traveler and the explorer are usually first attracted to regions which are easily accessible and whence it is easy to retrace one's steps. The attitude of mind which is exhibited by the common expression "safety first" has been largely responsible for the trend of developments in mathematics. With the passing of years these safe permanent thought roads have acquired historic interest and they have naturally been used as models by those who aim to open up scientific regions where mire and quicksand impede progress, and sometimes engulf roads which had been supposed to be secure.

The chief function of mathematics in scientific research is, however, not the cultivation of a feeling of modesty or of a desire for mental travel and exploration. The problem of the mathematical investigators is a much more difficult one, since it relates to the discovery and development of unifying processes which are sufficiently comprehensive to avoid bewilderment as a result of a maze of details, and yet sufficiently close to the concrete to become useful in the widely separated fields of scientific endeavor. With the growth of scientific knowledge in various fields, the problems of the mathematical investigators becomes more complex, and the world has never been in greater need for more mathematics than at the present time, since civilization never before called so loudly for perspicuity in science.

It is not an easy matter to characterize briefly and yet clearly the function of mathematics in the broad field of scientific endeavor. A prominent feature of mathematical work is that it changes postulates or assumptions into different forms, which are sometimes more readily accessible for experimentation than the original postulates were or are more directly useful in the solution of other scientific difficulties. The transformation of postulates, or accepted conclusions, is not peculiar to mathematics, but is common to all sciences. In mathematics these transformations, or the results derived therefrom, serve as a means to obtain new transformations, while in the other sciences they serve as a means to wrest from nature a new truth. Mathematics is commonly guided by current hypotheses about nature in the selection of her postulates, but after these are once selected, she is interested in building up a world for herself by constructions which are necessary consequences of these postulates. If these constructions represent only a small fraction of the interesting questions which appear to become clarified by logical

processes, mathematicians are perhaps not to be blamed for their reluctance in leaving extensive developments, which seem to admit of growth in every direction, for new fields where mathematical insight appears more or less uncertain.

The mathematicians, therefore, may be regarded as the old conservative party among scientists. They are the standpatters among the scientists of to-day. This does not say that they are making no progress. On the contrary, they have made and are making rapid progress, and are entering new fields, but fortunately the world is moving ahead so rapidly scientifically that no scientific party is able to embody in its platform all the desirable new features. In times of revolution conservatism is not apt to be popular, and in the midst of the scientific revolution in which we are finding ourselves the mathematical party is naturally receiving blows which the calmer days of the future will doubtless declare to have been too severe. These blows tend at the present time to work downward into our elementary and secondary education and they ought to be matters of great concern for all scientists; for, without the clarifying influence of mathematics, the whole structure of science would suffer seriously.

In recent decades the churches of our land have tended towards unity in action and towards a higher appreciation of the merits of the great common principles. Is it not likely that what is common to all the sciences, viz., the formation of ideas and the investigation of relationships existing between these ideas, will receive more emphasis as we understand better the value of scientific work? Monopoly in science is the worst type of monopoly. Mathematical ideas have an unusually wide range, but are comparatively barren in local content, for the richer an idea is, as regards local content, the poorer it usually is as regards range.

The present movement to organize research work is strongly represented in England by the Imperial Trust for the Encouragement of Scientific and Industrial Research and the Advisory Council. In America this same movement is represented by the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science, appointed in 1914,[2] and its various subcommittees appointed in 1916, and by the National Research Council, organized on September 20, 1916, by the National Academy of Sciences at the request of the President of the United States, and its plexus of committees representing the various domains of science.[3] This movement should tend to emphasize the common ground of scientific research as well as to clarify the atmosphere by directing attention to the fact that there are many grades of scientific research. It should be emphasized that the greatest danger of research to-day is that its popularity tends to research hypocrisy.

While the common ground of scientific research can not be said to be mathematics at the present time, it will doubtless be admitted that its ideal is mathematics. In fact, this common ground consists largely in so coordinating facts of observation or deduction as to lead to certain conclusions. These conclusions are not always necessary, but with the advance of knowledge they naturally tend towards becoming necessary. As soon as the conclusions become necessary, if certain explicit assumptions are made, and are not merely very probable, the reasoning becomes mathematical. Mathematical reasoning thus appears to be the goal towards which scientific reasoning is striving, and lack of sufficient knowledge furnishes the main reason why mathemat-

[2] SCIENCE, N. S., Vol. 39 (1914), p. 680; Vol. 45 (1917), p. 57.

[3] *Proceedings of the National Academy of Sciences*, Vol. 2 (1916), p. 607.

ical reasoning is not now more commonly used in scientific research. This may serve to explain the following assertion recently made by Professor H. S. White:

> Most scientists can and will become mathematicians when their special problems reach the stage where measurements are possible.[4]

It may be desirable to direct attention to the fact that the mathematician might almost be said to cease to be a mathematician when he becomes an investigator. It is true that he needs a large and growing amount of mathematical knowledge in order to investigate successfully. The flood of valueless literature contributed in recent years by non-mathematicians who endeavored to solve the great prize problem, known as the Greater Fermat Problem, has emphasized the fact that, in mathematics, as well as in other sciences,

> important advances in knowledge are far more likely to issue from the expert than from the inexpert. Indeed, the probability of extending knowledge by organizations conducted by disciplined investigators is so much greater than the probability of extending knowledge by the dragnet method that we not only may but should ignore the latter in comparison with the former.[5]

The mathematical investigator can clearly not afford to forget his knowledge of mathematics, but it is questionable whether he can afford to confine himself to mathematical reasoning while he is aiming to advance his subject. He needs imagination and ability to foresee results long before his mathematical machinery has enabled him to establish them. Unless we become like children in faith and fancy, we should not expect to add much that is fundamentally new to the kingdom of mathematics. As investigators we all have much more in common than as students of what has been done by others, and this common ground naturally increases with the originality of our investigations.

This common ground of investigators may serve to explain the fact that many of the most influential research organizations, like the National Academy of Sciences in our own country, embrace all the sciences. In recent decades there has been a tendency to organize research separately in the various subjects in the form of national societies named after these subjects. In fact, there are those who think that the latter have assumed such a preponderant sphere of influence as to threaten the very life of the former as serious factors in research. On the other hand, the maintenance of a common scientific life seems to be of the highest importance in view of desirable interactions and special emphasis on what is most fundamental.

The history of mathematics has taught us that some subjects which were apparently far apart and which were long developed separately were later seen to have most important common elements. The discovery of these common elements and their development has led to marked advances in the separate fields themselves. By way of illustration I need only refer to the fields of algebra and geometry so happily welded through the work of Descartes, Fermat and many others. In modern times the theory of groups and invariants has exhibited many important connections between subjects which had been supposed to be widely separated. The same tendency has, of course, manifested itself in other sciences and may be assumed to become more dominant as knowledge advances.

A pertinent difference between the mathematical investigators and investigators in other sciences is that the former are compelled to stay with their problems until a solution is reached which can be proved to be in accord with deductions from certain definite assumptions, while the latter enjoy

[4] H. S. White, SCIENCE, N. S., Vol. 43 (1916), p. 587.

[5] R. S. Woodward, SCIENCE, N. S., Vol. 40 (1914), p. 221.

much greater freedom in regard to the stage to which they may pursue a problem before announcing results. Hence these may hope for success in dealing with much more difficult questions than the mathematician could reasonably hope to solve at the present time. The limitations thus imposed upon the mathematician are compensated, at least in part, by the finality of his results as regards questions of rigor. Mathematical results *can* never be disproved, other accepted results *have* never been disproved. With respect to simplicity and style, the mathematical developments are seldom final, and in many cases, they appear to admit endless variations.

As instances of final mathematical results may be cited the useful tables which when once computed serve all succeeding generations. Such finality may be said to be a goal of all scientific endeavor, since the results enrich countless ages by increasing their capacity for accomplishments. In fact, such tables may be regarded as typical illustrations of the mathematical contributions to the advancement of knowledge even if they constitute a very minor portion of these contributions. The fact that mathematical results have increased the capacity of the world for doing things may be emphasized by noting, in particular, that in recent years prime numbers have been found which could not have been proved to be prime by the method employed by Eratosthenes, if the entire human race had been working in an organized manner on this single problem since the days of the ancient Greeks.

The present seems to be an especially appropriate time to consider the interrelations of scientific research in view of the rapidly growing public appreciation of the value of such research. Several decades of comparative peace immediately preceding the present great and deplorable conflict were unusually rich in great scientific triumphs. As well-known instances we may cite wireless telegraphy and the construction of the great Panama Canal, which became possible by our advanced knowledge in regard to sanitation. The world-wide health activities under the auspices of the Rockefeller Foundation and the activities of our agricultural colleges in directing attention to advantages resulting from scientific methods of farming are strong forces working towards a popular appreciation of science. Since the great European war began it has become evident through the new elements introduced by the submarines and other scientific devices that the very existence of a great nation may depend upon the scientific attainment of its people, and hence the question of scientific research has taken a prominent place among those of national policy. It is perhaps significant that our National Academy was founded in the midst of the Civil War.

Scientific research is as old as civilization and has often been protected by kings in a patronizing manner, but it is a new experience in the history of the world to see kings turn to scientific research for protection. For centuries governments have recognized the value of science and have provided with growing liberality for her development, but now they are calling to her to save them from destruction. They have noticed that in spite of many excellencies in other directions the ignorance of causes may entail their destruction as separate nations. This new attitude towards our field of work may at first tend to gratify us, but a second thought reveals the fact that it is fraught with grave dangers. Kings in government and finance are interested in the dead results of science instead of in the great living and growing organism itself, whose growth seems to have just begun and whose development has always been more keenly inspired by love of truth than by hope of gain.

Is there not a danger that the sudden recognition of the great political importance of certain types of research will have somewhat the same effect on science as the discovery of gold in California and in Australia about the middle of the preceding century had on the development of the regions concerned? People flocked from one mining camp to the other and often neglected duties which are essential for the harmonious development of the resources of a country. Hence there seems to be a special need at present to urge our colleagues to remain at their posts of duty, notwithstanding glowing reports of chances to amass scientific fortunes quickly in certain newly discovered gold fields. The get-rich-quickly schemes in science should be scrutinized as carefully as similar schemes relating to the accumulation of money.

The remaining at one's post of duty in scientific research does not imply a lack of support in the solution of pressing problems or a lack of vacation trips and acquaintance with other fields of work. In fact, such support and acquaintance are highly desirable. It is, however, a question whether the nomadic scientific life, which seems to have become fashionable during the last few decades, at least in mathematics, is the one which will in the long run bring the best results. Science is not primarily a grazing country. Large tracts are suited for agriculture and mining. What is new is not necessarily good and what is good is not necessarily new, and prophesies in regard to the great importance of certain new developments have not always been fulfilled. On the other hand, it should be remembered that reasonable hope and optimism are essential for progress, and that we need prospectors as well as miners in the scientific world.

It should be noted that the miner needs some of the qualifications of the prospector since he is apt to meet with new situations and needs to take advantage of the available by-products. In fact, while he is mining for gold he may strike deposits of copper which are richer than the gold deposits which he was primarily seeking. Some of the richest mathematical discoveries were made while the investigator was looking primarily for other results, and even problems which have not been solved at all up to the present have been the source of very useful developments. I understand that similar conditions hold in other fields of scientific effort and these facts point to the great importance of freedom on the part of the investigator, and, incidentally to the danger of too much organization in scientific research.

As a very recent instance of an unexpected mathematical by-product, I may be pardoned for referring to a somewhat trivial case which has, however, the important property that it can be understood by all. It is well known that the theory of substitution groups was developed for the purpose of clarifying the theory of algebraic equations and not for the purpose of adding to the enjoyment of parties engaged in playing games of cards. In fact, the study of such an advanced mathematical theory as that of substitution groups might appear to involve concepts, which are at the opposite pole from those entering the minds of people seeking recreation at card tournaments.

Notwithstanding this apparent wide separation, I was pleased to be able to say recently to a friend, who desired to have each one of a large party play once and only once with each of the others during a series of successive games, that an arrangement of the players meeting this condition could be determined directly by means of substitutions of certain transitive groups. This should perhaps have been expected, since a transitive substitution group is an ideal republic treating all its letters in exactly the

same way. On the contrary, an operation group may have elements enjoying special privileges and hence it has more extensive contact in the actual world of thought.

A little study of the stated problem revealed the interesting fact that when the number of tables is any power of 2 the substitutions of a well-known type of substitution groups and its group of isomorphisms exhibit directly how the players can be arranged so that each one will play once and only once with, and twice and only twice against, each of the others in a certain series of games. To make myself perfectly clear, I may say that if 8 tables, or 32 players, are involved, one can write directly by means of a certain regular substitution group of order 32 a set of possible arrangements so that in 31 successive games each one of these 32 players would play once and only once with each of the others and twice and only twice against each of them. This was, however, not the first solution of the general problem in question. In fact, about twenty years ago Professor E. H. Moore published a different solution of it in Volume 18 of the *American Journal of Mathematics* under the title "Tactical Memoranda."

I have referred to this matter here mainly for the purpose of emphasizing the fact that intellectual penetration is often attended by the most unexpected by-products, but I should also be pleased to have people know that certain kinds of recreation can easily be enriched by making use of results which the mathematician developed for a totally different purpose. Science should and does enrich both work and play. More than a thousand years ago the Hindu astronomer Brahmagupta said:

> As the sun obscures the stars, so does the proficient eclipse the glory of other astronomers in an assembly of people by the recital of algebraic problems, and still more by their solution.[6]

The playful question, "Where do the finger nails find so much dark dirt to put under them? may serve to arouse a thoughtful attitude on the part of the boy who has been taught to keep his hands clean. In fact, our play and recreation are perhaps as fundamentally affected by questions of science as our serious work and the victrolas and moving pictures should have a marked influence on the popular attitude towards science in view of the fact that they reach so many people. If it is true that the greatest service which science is rendering the human race is the reduction of superstition, it is clear that the efficiency of science depends largely upon its popularity.

The hypothesis that space and the operations of nature are discontinuous clearly excludes the hypothesis that they are continuous, but it is interesting to note that the mathematics relating to the discontinuous does not exclude that relating to the continuous. On the contrary, there are the most helpful interrelations between these two types of mathematics. Such a subject as number theory, relating decidedly to discrete quantities, has been greatly extended by analytic methods relating to continuous quantities, and, on the other hand, processes relating to the study of continuous functions are largely based upon those relating to the discontinuous.

This may perhaps tend to show that even if our hypotheses in regard to the continuity of space and the operations of nature have to be largely modified, as seems now probable, the mathematical methods of attack may require less modification than might at first appear to be necessary. The language which mathematics has provided for science includes not only concepts relating to the continuous and the discontinuous, but fortunately it also shows relations between these concepts and these relations

[6] H. T. Colebrooke, "Algebra with Arithmetic and Mensuration from the Sanscrit," by Brahmagupta and Bhascara, 1817, p. 379.

become more pronounced with its development.

In view of the age of this language and its contact with various sciences it may be readily understood why mathematical history occupies a prominent place in the history of science. In fact, the history of science constitutes one of the fields where scientists may find common interests most fully represented, even if the past is too rich in events to be studied completely. It may therefore be appropriate on this occasion to refer to a few recent developments relating to the history of mathematics, especially since the interest in the history of science has increased rapidly during recent decades, as is partly evidenced by the efforts that are now being made to establish an institute of historical scientific research in our land.

One of the most interesting questions relating to the early history of mathematics is the use of positional values of numbers and the closely connected use of a symbol for zero. Until a decade or two ago it was commonly assumed by mathematical historians that the use of zero as a positional number symbol originated in India, and this view has not yet been entirely abandoned, notwithstanding the fact that the Babylonians employed numbers with positional value and a symbol which seems to have fulfilled the main function of our zero several centuries before the Christian era. On the other hand, the first definite evidence of the use of zero among the Hindus falls in the second half of the first millennium of this era.

In view of these facts it is extremely interesting to note the early use of zero, in connection with numbers having positional value, by the Maya, a people inhabiting the Atlantic coast plains of southern Mexico and northern Central America. One of the worthy alumni of your university recently referred to this matter in the columns of SCIENCE in the following words:

> Special interest attaches to the occurrence of zero-symbols and the principle of local value among the inhabitants of the flat lands of Central America, at a period as early as the beginning of the Christian era, if not much earlier. It would seem that in this invention, the Maya in Central America possessed priority over Asiatic people by a margin of five or six centuries.[7]

If further investigation will lead mathematical historians to agree that the zero as a symbol in a numerical notation with positional value was actually first used in America, according to the preserved records, it will effect a very fundamental change as regards interest in the early mathematical attainments of the American aborigines. Unfortunately these early mathematical attainments failed to become the source of extensive further developments on American soil. They exhibit clearly that central concepts may be discovered independently and they direct attention to the danger in trying to establish one source for a particular concept in historical investigation. They also show that the small strip of country marked now by Boston has not always been the intellectual hub of America.

The history of some of the mathematical attainments of the Maya people has recently been made more easily accessible through the publication of "An Introduction to the Study of the Maya Hieroglyphs," prepared by S. G. Morley and published as Bulletin 57 of the Bureau of American Ethnology, Smithsonian Institution of Washington. On page 92 of this bulletin a dozen different symbols for zero are noted and on page 131 numbers varying from 21 to 12,489,781, and involving the use of zero, are represented in the Maya notation. It is of interest to note that the

[7] F. Cajori, SCIENCE, N. S., Vol. 44 (1916), p. 715.

value of a unit in a higher position is always 20 times the value of a unit in the next lower position, except in the case of the third place, where its value is only 18 times that of the second place.

In historical research and elsewhere, the mathematician seeks cordial cooperation with other scientists, and he regrets that the confusion of tongues, resembling the experiences at the tower of Babel, is making it more and more difficult to understand each other. In the case of scientists this confusion is mainly due to a rapid growth of language in various directions. May we not hope that as many theories which were supposed to be distinct suddenly exhibited profound connections, so also this extensive language will tend towards unity and simplicity as we see more clearly the fundamental underlying principles. Science knows no bounds in method or in subject-matter and the artificial limitations set by man for his own convenience in making a start must break down before the onward march of truth. All science is a unit and all scientific investigators should be inspired by their common interests.

G. A. Miller

University of Illinois

SCIENTIFIC EVENTS

FORESTRY ORGANIZATION FOR THE WAR

A "forestry regiment," made up of foresters, practical woodsmen, loggers, portable sawmill operators and others experienced in lumbering operations, for service in France, will, it is announced, be raised immediately. The Forest Service, at the request of the War Department, will prepare plans for the organization and equipment of the force and will aid in securing suitable men. The regiment will form a unit of the Engineer Corps now being recruited to be sent abroad as soon as it can be organized and equipped.

The organization of this regiment is the result of a suggestion made by the British Commission. Similar forces have been raised in Canada and are rendering valuable services. The object of the American forestry regiment, it is said, will be to convert available timber into material suitable for bridges, railroads, trenches and other construction work with the least possible waste. At the same time the cutting will be done under the supervision of technical experts in cooperation with the French foresters. In this way the permanent damage to the forests incident to furnishing the imperatively needed timber, it is hoped, will be kept as small as possible.

The regiment will be organized in units capable of handling all kinds of woods work and will include a number of portable sawmill outfits. It will be officered by trained foresters and expert lumbermen who are thoroughly familiar with producing and delivering lumber. It will carry complete equipment for all kinds of woods work. The classes of men desired comprise axemen, teamsters, tie-cutters, millwrights, saw-filers, sawyers, portable sawmill men, farriers, blacksmiths, lumberjacks, cooks and carpenters, as well as motorcycle and motor-truck operators. As rapidly as enlistments are secured, the men will be assembled at six central points, which have already been designated.

EXPEDITIONS OF THE SMITHSONIAN INSTITUTION

A letter from Mr. H. C. Raven recounts the collection of many kinds of wild rats, shrews, bats, squirrels, etc., made in the East India Islands. The first shipment received at the National Museum included 319 mammals and about 300 birds. Mr. Raven recently explored the central part of Borneo, thence working southward by cart and pack train, and is now supposed to be in the southern part of the island. Another collection of miscellaneous matter just received from Mr. Raven includes ethnological specimens, mammals, birds, also reptiles, shells and insects.

Mr. Arthur deC. Sowerby, who has been exploring in China for the National Museum, has not been very successful owing to the conditions there, but managed to visit Shanghai and several places on the lower Yangtze. A

letter from him reports as follows: "My recent trip, to Che Kiang was brought to a summary close by the outbreak in that region. I could not get any transport and very nearly had my retreat cut off. Nothing can be done until the provinces have come to an agreement as to just how the government is to be run. There is only north Chili (a province of China) left to work in and I hope to go there in the autumn. China is in such an unsettled state that if it were not for the war in Europe it would be attracting everybody's attention. Conditions are no better than they were during the revolution of 1911."

Dr. W. L. Abbott, who has enabled the institution to take part in much field work during the past thirty years, and who is now financing the explorations of Mr. Raven, has made a short collecting trip to Santo Domingo. On this island, which was the scene of Dr. Abbott's earliest expedition, in 1883, he collected a number of mammals, birds, reptiles, mollusks, insects and Indian relics.

Mr. John B. Henderson, a regent of the Smithsonian Institution, has conducted a series of dredgings from his yacht *Eolis* off Key West, Florida. Owing to the exceptionally good weather conditions and to the fact that the Gulf Stream had receded much farther off shore than is usual, the party was enabled to carry on most successful operations upon the Pourtales Plateau. This is a strip of rocky bottom off the Florida Keys extending some forty or fifty miles and lying between the depths of 100 and 200 fathoms. It is one of the richest localities in American waters with a fauna peculiarly its own. The material collected covers all groups of marine invertebrates.

Dr. Paul Bartsch, of the National Museum staff, and Mr. John B. Henderson, also collected in Cuba, the Florida Keys, and in Florida, where marine invertebrates were secured by dredging. The Cerion Colonies composed of land mollusks from the Bahamas, planted some time ago by Dr. Bartsch in the Florida Keys, as an experiment to discover the effect of the environment, were examined. Observations and notes were also made on the birds seen on the islands visited.

APPROPRIATIONS OF THE GENERAL EDUCATION BOARD

THE General Education Board, disbursing moneys from the John D. Rockefeller Fund for the promotion of education, has announced annual appropriations amounting to $878,004. It is announced also that since the University of Chicago has raised $3,461,500 for its medical school, subscriptions of the General Education Board and of the Rockefeller Foundation, amounting to $2,000,000, become valid at once.

By a final gift of $350,000 to the Johns Hopkins Medical School the board announced that it had completed its contribution of $1,750,000 for full-time medical teaching in that institution. When the board announced the first of its gifts for the reorganization of the departments of medicine, surgery and pediatrics in Johns Hopkins, the total contributions were set at $1,400,000.

Aims of the board in making the gift were expressed then by the Rev. F. T. Gates, then chairman, in these words: "We think it important that the clinical subjects should be cultivated and taught by men freed from the distraction involved in earning their living through private practise. They will henceforth be in a position to do any service that either science or humanity demands." The fund thus completed is known as the William H. Welch Endowment for Clinical Education and Research.

In announcing the release of the money for the University of Chicago the board added that its policy was to "use its funds with a view to inducing others to cooperate toward the same ends. Thus its contributions for nearly all purposes are supplemented by other gifts secured through the cooperation of the General Education Board."

Annual appropriations to other funds and for other educational purposes as planned in former years were:

To Monmouth College, Monmouth, Ill., $60,000 toward a total of $250,000.

To Ottawa University, Ottawa, Kan., $100,000 toward a total of $400,000.

For professors of secondary education in state universities, $35,130.

For state agents for rural schools, $53,200.

For rural education of negroes, $50,974.

For current support of negro colleges and industrial schools, $102,200.

For farm demonstrations, including canning club work and boys' corn and tomato clubs in Maine and New Hampshire, $36,500.

Additional appropriations for various projects, aggregating $80,000, of which the sum of $50,000 was given for the purpose of promoting educational studies and research.

In making this last appropriation of $50,000 for educational research the board is continuing a policy begun two years ago.

It was also announced that Frederick T. Gates, who has been Mr. Rockefeller's adviser in benefactions for many years, had resigned from the chairmanship of the board. He is to be succeeded by Dr. Wallace Buttrick, who has been secretary. Mr. Buttrick's place is taken by Dr. Abraham Flexner.

THE RAMSAY MEMORIAL FUND

As was noted in SCIENCE at the time a public meeting was held last October at University College, London, to consider the best means of establishing a memorial to the late Sir William Ramsay. We learn from *Nature* that since then the organization of the appeal has been set up and is now complete. Mr. H. H. Asquith has consented to act as president of the fund, whilst the vice-presidents include the ambassadors and ministers of allied and neutral powers, Mr. Lloyd George, the president of the Board of Education, the president of the Royal Society and the chancellors of the universities of Cambridge, Glasgow and London. The general committee, consisting of the subscribers, is under the chairmanship of Lord Rayleigh. Lord Glenconner and Professor J. N. Collie share the office of honorary treasurer, and Dr. Smiles is acting as honorary secretary.

An executive committee, formed under the chairmanship of Sir Hugh Bell, has drawn up an appeal, which is at present only privately issued, but will shortly be circulated publicly. The committee aims at obtaining a sum of £100,000, and whilst the final form to be taken by the memorial will be submitted to the subscribers, and will necessarily depend on the amount obtained, the objects recommended are: (1) The provision of Ramsay Research Fellowships, tenable wherever the necessary equipment may be found; and (2) the establishment of a Ramsay Memorial Laboratory of Engineering Chemistry in connection with University College, London, where Sir William Ramsay's most important discoveries were made during his twenty-six years' tenure of the chair of chemistry. The committee has also in mind the inclusion of other forms of memorial, such as the institution of a Ramsay Medal for Chemical Research.

The sum already obtained by the private efforts of Sir William Ramsay's friends and from their own generosity amounts to about £13,500. This includes the donation of £5,000 from Messrs. Brunner, Mond, Ltd.; £1,000 each from the Rt. Hon. Lord Glenconner, Sir Hugh Bell, Sir Ralph C. Forster, Sir Robert Hadfield, Mr. Robert Mond and Mr. Hugh Brunel Noble; and £500 each from the president of the British Science Guild and Miss Lilias Noble.

SCIENTIFIC NOTES AND NEWS

THE New York Academy of Sciences has been compelled to postpone the celebration which had been planned, but on the evening of May 28 the following program was given in honor of the one hundred years of scientific activity of the academy:

The relation of pure science to the national crisis: Professor Michael Idvorsky Pupin, president of the academy.

The academy's scientific survey of Porto Rico: Dr. Nathaniel Lord Britton.

Our first hundred years—a summary: Dr. John Hendley Barnhart.

PROFESSOR T. H. MORGAN, of Columbia University, has been elected a foreign member of the Linnean Society, London.

DR. ISAIAH BOWMAN, director of the American Geographical Society, was in April awarded the Bonaparte-Wyse gold medal of the Geographical Society of Paris for his explorations in and publications on South America.

WE learn from *Nature* that the Pereira prize of the Pharmaceutical Society of Great Britain has been awarded to Miss Ivy Roberts, and the silver and bronze medals of the society have been awarded, respectively, to Mr. H. Jephson and Miss Doris Gregory. The Hanbury gold medal has been awarded to Professor H. G. Greenish, professor of pharmaceutics to the Pharmaceutical Society.

THE Swedish Society of Physicians has elected Colonel Robert Jones, C.B., inspector of British military orthopedices, to be a foreign member.

THE Jacksonian prize of the Royal College of Surgeons of England for 1916 has been awarded to Mr. E. W. H. Groves for his dissertation on "Methods and results of transplantation of bone in the repair of defects caused by injury or disease." The subject for the Jacksonian prize for 1918 is "The injuries and diseases of the pancreas and their surgical treatment."

The British Medical Journal states that the post of director of the Institute for Experimental Therapy and of the Georg-Speyer House in Frankfurt-a.-Main, left vacant more than a year and a half ago by the death of Professor Ehrlich, has been given to Professor Kolle. He was one of Koch's pupils, and was his assistant when he investigated the causes of rinderpest in British South-west Africa in 1896. Kolle was then only twenty-eight. In conjunction with Pfeiffer, he investigated the problems of typhoid immunization, and the typhoid vaccine experiments carried out at the time of the Herero rising were continued during the present war. He has also made observations on cholera, plague and dysentery.

IT was announced at a resumed annual meeting of the Iron and Steel Institute of Great Britain that awards had been made by the council from the Carnegie Research Scholarship Fund to the following: Mr. W. C. Hancock, £50, to enable him to continue his investigations on refractory materials, with special reference to the manufacture of coke-oven bricks; to J. L. Nauchton and D. Hanson, a grant of £100 to enable them to continue their joint research on iron-phosphorous and iron-carbon-phosphorous steels; to J. Hurst a grant of £100 for an investigation on the wearing and the micro-structure of worn cast-iron specimens; to J. H. Whiteley and A. F. Hallimond, a grant of £100 for a joint research on the chemical detection of strain in iron and steel.

CHANCELLOR DAY, of Syracuse University, has appointed the following representatives from the faculty, trustees and alumni to act as the local Research Council: Dr. C. W. Hargitt, *chairman*; Professor E. N. Pattee, *secretary*; Dean W. P. Graham, Acting Dean Frank F. Moon, Dr. Frank P. Knowlton, Mr. Edmund L. French, Mr. William J. Harvie.

PROFESSOR GEORGE R. MCDERMOTT, the professor of structural design in Sibley College, has been appointed a member of the staff of General George W. Goethals, who is taking charge of the construction of an emergency fleet.

DR. ALLERTON S. CUSHMAN, president of the Institute of Industrial Research, with headquarters at Washington, has been commissioned a major in the Officers' Reserve Corps, and will do special research work under the ordnance section on the chemistry of high explosives.

MR. HARRY S. SWARTH has accepted the position of curator of ornithology and mammalogy in the museum of the California Academy of Sciences, and will enter on the work on October 1. Mr. Swarth has been curator of birds in the museum of vertebrate zoology of the University of California since 1915. He is a fellow of the American Ornithologists Union.

DR. THOMAS CROWDER, medical director of the department of sanitation and medicine of the Pullman Company gave a lecture on May 14 at the University of Illinois College of Medicine, his subject being "Ventilation and sanitation of sleeping cars."

THE Bakerian lecture of the Royal Society was delivered by Mr. J. H. Jeans on May 17 upon the subject of the configuration of astronomical masses and the figure of the earth.

Sir William Osler delivered the annual oration of the Medical Society of London on May 14. His subject was "The anti-venereal campaign."

The Sydney Ringer biennial memorial lecture was delivered on Friday, May 25, at the University College Hospital Medical School, London, by Professor A. R. Cushny, on "Digitalis and auricular fibrillation."

A statue of Berthelot, the great chemist, has been unveiled in the gardens of the Collège de France. He did much of his work in the laboratories of the college.

Miss Nellie Fosdick, instructor in botany at Wellesley College, died on May 19.

Miss Ruth Holden, Alice Freeman Palmer fellow in botany at Wellesley College from 1914 to 1915, has died in Moscow, Russia, from typhoid fever, contracted during her work as a member of the Red Cross relief work for Polish refugees in Russia.

Sir Marc Armand Ruffer, distinguished for his work in preventive medicine, has lost his life while engaged in Red Cross work.

Major P. G. Bailey, known for his work in genetics, was killed in action on April 26.

The death is announced at Paris of Louis Landouzy, known for his work in tuberculosis, aged seventy-two years.

Professor H. F. E. Jungersen, professor of zoology and director of the zoological museum in the University of Copenhagen, has died at the age of sixty-three years.

A new journal for physical anthropology has been established in Italy. It will be known as the *Giornale per la Morfologia dell' Uomo e dei Primati,* and is edited and published by Professor G. L. Sera, of the University of Pavia.

The Angrand prize of the Bibliothèque Nationale of Paris, of the value of 5,000 francs, is to be awarded in 1918 for the best work published during 1913–17 on the pre-Columbian history, ethnography, archeology or linguistics of the American aborigines.

We learn from the *British Medical Journal* that the triennial prize of the Royal College of Surgeons of England, consisting of the John Hunter medal in gold to the value of fifty guineas, or, at the option of the author, a medal executed in bronze, with an honorarium of £50, will be awarded for the best essay on "The development of the hip-joint and the knee-joint of man." Essays must be received at the college not later than Tuesday, December 31, 1918. The subject of the Jacksonian prize for this year, essays in competition for which must be received on December 31, 1917, is "The causation, diagnosis and treatment of traumatic aneurysm, including arterio-venous aneurysm." As already announced, the subject of the prize for 1918 is "Injuries and diseases of the pancreas and their surgical treatment."

The Lakeside laboratory of the Iowa State University on the shores of Lake Okoboji, begun nine years ago by President Emeritus Thomas H. Macbride, will open its annual session on June 18. The staff of instruction, in addition to members from the university, will include Professor T. C. Stephens, of Morningside College, zoology, and Mr. A. F. Ewers, of St. Louis, botany. Dr. F. C. Stromsten, of the university, has charge of work on aquatic animals. Professor R. B. Wylie, also of the university, is the director.

The annual summer courses which are given at the marine station of the University of Washington, Friday Harbor, are scheduled to begin on June 18, and will last six weeks. The work this session will be on the development of marine animals and will be under the supervision of Hjalmar L. Osterud, instructor in zoology at the university. He will be assisted by Dr. John Bovard, professor of zoology in the University of Oregon, who will give the general course in marine zoology. Dr. H. S. Brode, of Whitman College, will lecture in ecology, while Dr. Theodore C. Frye, professor of botany at the State University, will teach algology.

Professor Nelson C. Brown, head of the department of forest utilization at the New York State College of Forestry, Syracuse University, has obtained a leave of absence for one year and a half, and will go to Europe as a government trade commissioner in an investi-

gation of the lumber needs of the warring nations for reconstruction purposes. Early in May, the trade commissioners met at Washington for the purpose of organization. There they gathered data concerning tariffs, freight rates, probable future shipping facilities and other information bearing on the matter of lumber exports after peace has been declared. They will spend two or three months in visiting lumber-producing centers in this country, interviewing lumbermen. This preliminary work will be for the purpose of obtaining exact knowledge as to how much lumber the European countries now at war can purchase here and in what particular markets. Professor Brown and his associates expect to sail for Europe in August or September.

THE Johns Hopkins *Alumni News* states that it has lately become known that two of the most successful devices introduced by the allies in the present war are due to Dr. Robert W. Wood, professor of experimental physics. They are the lachrymose or "tear" gas, used to render the enemy temporarily blind, and a photographic screen of a special type, which is especially well suited to the requirements of modern warfare. Dr. Wood sent the formula for the former to a friend in Paris soon after the outbreak of the war. Several weeks after submitting his plan, Dr. Wood received word that it had been turned over to the proper authorities. Nothing was done, however, until three months later when the Germans began the use of poisonous gases; since then the tear gas proposed by Dr. Wood has been used on both sides. The gas has a powerful effect on the eyes, the slightest trace closing them and starting the tears. It is benzyl-bromide, or choracetone, vapor and produces temporary blindness but not permanent injury. Its use was in no way a violation of The Hague conventions or the usages of civilization. It was Dr. Wood's idea that the gas might be used in a single great drive, being released over the whole battle front simultaneously. The other of Professor Wood's inventions being used extensively in the fighting on the west front is the infra-red screen for the panchromatic plates for photography. By the use of the screen the Allied airmen are enabled to obtain accurate photographs of the enemy's position, batteries, etc., right through the thick pall of smoke which hides them from view.

UNIVERSITY AND EDUCATIONAL NEWS

YALE UNIVERSITY has received from Mrs. Edward H. Harriman, of New York, bonds yielding $4,600 a year for the purpose of establishing the Harriman Fund for Orthopedics.

THE late J. T. Apperson, member of the board of regents of the Oregon Agricultural College since its founding and at one time president of the board, left the residue of his estate to the trustees of the college as a permanent loan fund to worthy students who make their own way through school. The benefaction will amount to from $25,000 to $40,000, and will be invested by the State Land Board.

THE new building of the dental school of Western Reserve University is nearing completion and will be occupied in the fall of 1917. The building is situated alongside the university campus and near the site for the new medical school plant. The dental school, formerly affiliated, is now an integral department of the university. An extensive revision of the curriculum and an increase in entrance requirements are contemplated.

SIR CHARLES HOLCROFT bequeathed to the University of Birmingham the sum of £5,000 for research work in science. Sir Charles Holcroft contributed, during his lifetime, about £100,000 to the university.

THE board of trustees of the Long Island College Hospital announces the appointment of Dr. James C. Egbert, director of extension teaching, Columbia University, as president of the medical college. Dr. Otto V. Huffman has been appointed dean; Dr. Wade W. Oliver, formerly of the University of Cincinnati, has been called to the chair of bacteriology and Dr. Carl H. Laws, formerly of the department of pediatrics in the University of Michigan, has been appointed professor of pediatrics.

DR. J. BRONSENBRENNER has resigned the position of director of research laboratories of the Western Pennsylvania Hospital in Pittsburgh to accept the appointment of associate

professor in the department of hygiene at the Harvard Medical School.

Dr. George D. Louderback has been advanced from associate professor to professor of geology at the University of California.

Professor D. L. Crawford, of Pomona College, Claremont, Cal., has been appointed professor of entomology in the College of Hawaii, Honolulu, for a term of three years, beginning in September, 1917.

DISCUSSION AND CORRESPONDENCE

A TOPOGRAPHIC MAP OF WISCONSIN

The movement to expedite the completion of the topographic map of the United States by the U. S. Geological Survey, of which some account was given in Science a year ago, is today greatly promoted by the increased interest in topographic preparedness on the part of army officers. Doubtless at their instance the sum of $200,000, in addition to the usual large appropriation for topographic maps under the Geological Survey, has lately been voted by Congress to be expended for geodetic and topographic surveys at the discretion of the Secretary of War. Members of the Coast and Geodetic Survey and of the Geological Survey have already taken the field, chiefly in the Southern States, in areas designated by the war department, and a much desired increase in topographic output will be the result. It is interesting to note in this connection that, although the additional sum thus appropriated is spent under military direction, the work for which the sum is spent is performed by the experts of the two civilian surveys, who are all listed in the reserve corps.

In the meantime the civil uses of topographic maps must not be forgotten, and among these the educational uses are by no means the least important. An excellent statement of them follows with respect to the needs of a single state in a letter by Professor Lawrence Martin, of the University of Wisconsin, to the state engineer at Madison. Educators and engineers elsewhere would do well to organize a similar movement for promoting the topographic survey of their states also.

W. M. Davis

LETTER, DATED MAY, 1917, FROM PROFESSOR LAWRENCE MARTIN, OF THE UNIVERSITY OF WISCONSIN, TO THE STATE ENGINEER AT MADISON

My Dear Sir: In support of the proposed state appropriation for topographic maps I am writing to explain the need of these maps for educational purposes. This is only one of the many uses for which I regard these maps as desirable, but it is the one to which I am giving especial attention as a member of our committee.

Topographic maps are an admitted need for school and college use, as explained later. Let us compare Wisconsin with Ohio, states not dissimilar in area, topography and educational system. We are proposing to ask the legislature for $20,000 a year for twenty years to complete the topographic map of Wisconsin in the next two decades. Twenty years ago there was not a single topographic map of any part of Ohio. Mapping was started nineteen years ago, and to-day the topographic maps cover the entire state. Every college, normal school, high school, grade school and other educational institution in Ohio has a topographic map of the home area for use by its students.

Twenty years ago Wisconsin had twenty-seven topographic maps. In these two decades we have added seventeen maps, while Ohio has added more than two hundred.

The states of Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Maryland and West Virginia are completely mapped. More than half of Kansas, Oklahoma, Utah, Arizona, California, Vermont, Virginia, Colorado, Tennessee and Pennsylvania are covered by topographic sheets. Only about a fifth of Wisconsin is mapped.

There are 413,000 school children in Wisconsin who live outside the area covered by topographic maps. Five of our nine normal schools have no topographic maps of their home area. Twenty-two of the county training schools for teachers and the county schools of agriculture are outside the mapped area. For fourteen of the cities which maintain continuation schools there are no maps. There is no topographic map covering the area about the Stout Institute at Menomonie. There are none for the colleges at Appleton (Lawrence University), at Plymouth (Mission House College), at Ashland (Northland College), at Beaver Dam (Wayland Academy), or for a number of the Catholic colleges and some of the private schools. There are no maps for the Indian schools near

Tomah, at Hayward, and on the other reservations (Carter School, etc.). Beside these there are many large high schools which need maps, some of them at places listed above, others at various cities.

Of course topographic maps are quite as important for the smaller cities and villages and for the country schools as for the places listed above. Wisconsin ought not to lag behind Ohio, New York, West Virginia, or any other state, or behind England, France, Germany, or Italy, all of which are completely mapped, in providing topographic maps for educational use.

In addition to the very necessary local use of topographic maps of the home area, it is desirable that students in one region should use the maps of other parts of the state. Pupils in the Milwaukee, Racine, Madison, Superior, and other high schools ought to have a chance to study topographic maps of the vicinity of La Crosse, Eau Claire or Ashland, where there are no maps as yet. Students in the country schools need them even more. College students at Beloit, Ripon, Milton, Carroll, Watertown, Marquette and Milwaukee-Downer, and normal-school students at Platteville, Whitewater, Milwaukee and Superior, where there are topographic maps, need maps of the other four fifths of Wisconsin where there are none.

At the University of Wisconsin we need not only the completed topographic sheets of the adjacent country, which our students now use extensively in laboratory work and field study, but maps of all other parts of the state, for our students come from everywhere in the state, they go back to all parts of the state to work or to teach, and we can not adequately study other parts of Wisconsin without maps of these decidedly different areas. The same thing applies to the other colleges, to all the normal schools, the large high schools, the country schools and the educational system generally. The State Geological Survey is considering a plan of publishing and distributing lists of topographic maps for schools of varied size and situation, with simple, comprehensive directions for their use in classes; this can not be done effectually until much more of Wisconsin is covered by topographic maps.

Very truly yours,

LAWRENCE MARTIN

WINTER ACTIVITY OF THE BROWN BAT, VESPERTILIO FUSCUS (BEAUVOIS), AT BROOKLYN, N. Y.

THE sporadic appearance of *Vespertilio fuscus* on mild winter evenings, in the latitude of New York, is a well-known phenomenon,[1] but the following account describes altogether extraordinary behavior on the part of a bat of this species.

A few minutes after five o'clock P.M., on February 14, 1917, Mr. George P. Engelhardt, of the Brooklyn Museum, and the writer entered the Brooklyn Botanic Garden with the purpose of finding a mocking-bird that had been observed to be wintering in the section of the grounds devoted to a Japanese garden. While we were hunting through a copse of evergreens bordering the small frozen lake, we were astonished to see a bat flying above the ice. The creature made several trips back and forth, over a distance of seventy or eighty yards, passing so close to us that we had no difficulty in recognizing the species. It circled about just as though it were pursuing insects over the water on a summer evening, except that its flight was slow and obviously labored, and we expected to see it drop at any moment. Presently it fluttered westward, beyond the end of the lake, and seemed to descend on a grassy meadow. We hastened in that direction, searching the ground, but, as we saw no more of the bat, Mr. Engelhardt left the Garden.

I then walked to the Botanical Laboratory in order to note the temperature, which was 30° F. The afternoon had been cloudy, and the setting sun shone only as a red ball through the calm, chilly, misty air. It is worth remarking that the first slight thaw after a protracted period of severely cold weather had occurred on this date. On the morning of the previous day, February 13, the thermometer had registered + 3° F., in this part of Brooklyn.

Returning to the edge of the lake at 5:25 P.M., I saw the bat again, and ran after it, but soon lost sight of it. Then, as I approached the outlet of the lake, I spied it on a sheet of thin ice almost surounded by the running water of the brook, three feet above a small waterfall. While I stood quietly within ten feet of it, the bat crawled rapidly about the ice, lapping it with its tongue. Next it

[1] Murphy and Nichols, *Sci. Bull. Brooklyn Inst. Mus.*, Vol II., No. 1, 1913, p. 7.

moved towards the margin, paused an instant, then deliberately plunged into the water. It swam strongly across the current, keeping its head, wrists, widely spread feet, and the tip of its tail above the surface, and making sculling strokes with its phalangeal membranes, which hung straight downward. The greater part of its back, and its interfemoral skin, except near the tip of the tail, were submerged. After reaching the ice a yard across the open stream, it turned and swam back, and attempted to clamber out at the point where it had entered. Like King Robert Bruce's spider, it made six vain trials but on the seventh it succeeded. It then shook itself in quadrupedal fashion, crawled across the ice to a nook beneath an overhanging rock, and lay still. I continued to watch it for five minutes, and was tempted to leave it until morning; but, realizing that it would soon be frozen to the spot, I picked it up.

In my hand it seemed perfectly active, at first struggling and biting characteristically, and giving vent to infinitesimal squeaks and to explosive puffs like the sound of a tiny one-cylinder engine. At times it would shake its head with a rapid vibration and snort loudly. Within a few moments it began to lick its membranes, comb its snout, ears and body with its long-clawed feet, then to clean the claws with its teeth, and, in short, to go through all the elaborate preening movements which make bats so extremely kitten-like. From time to time I noticed an evanescent, skunkish odor, which seemed as though it might be due to some periodical, perhaps defensive, glandular exudation. Its wet fur dried surprisingly quickly under the influences of the violent combing, and the high temperature that the animal soon developed by means of respirations at the rate of about 145 per minute.

The bat was an old female, with teeth worn down to a condition similar to that already described by Murphy and Nichols (*l. c.*, p. 8). Although it could have eaten no food for three months or more, it passed feces which proved to be composed principally of its own fur.

Probably the most noteworthy point about the whole incident is the record of an unwounded bat, certainly in full control of its bodily coordination, swimming in the icy water of a stream, apparently with intent.

Robert Cushman Murphy
Department of Natural Science,
Brooklyn Museum

DR. HOBBS ON THE HISTORY OF SCIENCE

To the Editor of Science: Touching the address of Professor William H. Hobbs to the Michigan Academy of Science, printed in Science (issue of May 11, 1917), I wish to point out:

1. That it is not customary among historians and students of history to consider the thousand years following the Hun invasions the "dark ages," or, as Professor Hobbs calls them, a "thousand years of stagnation" (p. 443) or "centuries of intellectual stagnation" (p. 442). No period which includes the thirteenth century can fairly be so described.

2. That Galileo never was tortured by the Inquisition (p. 443) and that the only "imprisonment" he suffered was in the homes of his friends.

3. That Giordano Bruno was burned for denying the divinity of Christ—not for advocating the Copernican doctrine.

4. That what Mr. Huxley termed "that chaff about the ego and the non-ego, about noumena and phenomena and all the rest of it, etc.," are not *mere* "metaphysical abstractions" in the sense that any thinking man can dispense with them. A thorough grounding in metaphysics (and logic) would be a very good start for a career in "science"; one does not know either intuitively and both are necessary for clear thinking and sound generalizing.

Thomas F. Woodlock
Mount Vernon, N. Y.

SCIENTIFIC BOOKS

Manual of Psychiatry. Fourth edition. Revised and enlarged. By J. Rouges de Fursac, M.D., and A. J. Rosanoff, M.D. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Limited. 1916. 8vo. Pp. 522.

Brevity, clearness of diction and simplicity of presentation with a sufficiently small num-

ber of points of discussion—these are the points which make a popular text for students. De Fursac and Rosanoff's book has gained a well-deserved place with medical students through these qualifications, and it will deserve it even more fully in the present form. Up to the present edition the text kept apart the translation and the translator's annotations. This distinction has been obliterated and in reality the book has been adapted much more definitely to the needs of the American student, at least in the chapters entitled "The Practise of Psychiatry," which give a helpful picture of the present-day dispensary and state hospital practise.

The book represents a somewhat extraordinary combination in view of the fact that it is primarily an adaptation of the German psychiatry to a French public and then a readaptation to the American viewpoints. French psychiatry has in the meantime shown some evidences of revolt and repudiation, and American psychiatry, if we can speak in such a summary way, shows signs of a considerable degree of emancipation. For the purposes of the student, however, it is most important that he get some reasonably clarified starting point, and with the qualifications of the original description by Rosanoff, the transition is made reasonably easy and will no doubt offer a good basis for further emancipation as further editions will demand it. It may be possible to eliminate some unnecessary evidences of translation such as the reference on page 21 to Jean Muller, whom probably most of us know as Johannes Mueller.

"In the first part of the book, the chapters dealing with etiology, history taking, methods of examination, special diagnostic procedures, general prognosis, prevalence of mental disorders, prevention, and medico-legal questions, and, in the second part, those dealing with Huntington's chorea, cerebral syphilis, and traumatic psychoses are either wholly new or almost so.

"The chapter on general therapeutic indications, in the first part of the book, and those on dementia præcox, chronic alcoholism, general paresis, and mental disorders due to organic cerebral affections, in the second part, have been more or less extensively revised or added to."

Rosanoff's standpoint with regard to heredity is very strongly emphasized in the book to the effect that he feels that "we are in a position to say to the people and to legislatures: Mental health is purchasable; the prevalence of mental disorders can be reduced for coming generations with the aid of dollars and cents spent for segregation in this generation."

For the problems of non-institutional care it might be wrong to expect too much help from a book. The problem of psychotherapy is treated rather briefly, but is one of those things that have to be learned from practise and with the help of special literature.

ADOLF MEYER

THE JOHNS HOPKINS UNIVERSITY

SPECIAL ARTICLES

A SUGGESTION REGARDING THE MECHANISM OF ONE-SIDED PERMEABILITY IN LIVING TISSUES[1]

IT is a familiar fact to physiologists that a large proportion of living tissues display a type of permeability markedly differing from the permeability or semipermeability of the majority of non-living membranes in that it is dependent upon direction, that is, upon the side of the membrane exposed to the dissolved substance. Among the almost numberless illustrations of this phenomenon which might be adduced it will be sufficient to cite the experiment of Cohnheim[2] in which a glucose solution, free from sodium chloride was introduced into an isolated loop of intestine. After the lapse of a certain period investigation of the residual fluid showed that while some fifty per cent. of the water and glucose had passed through the wall of the intestine into the blood stream, only an insignificant trace of sodium chloride had passed from the blood stream into the glucose solution. This is not the

[1] From the department of biochemistry, Rudolph Spreckels Physiological Laboratory, University of California.

[2] O. Cohnheim, *Zeitschrift f. Biologie*, 36 (1898), p. 129.

case if the glucose solution be placed in the peritoneal cavity instead of in the intestine. In this case the peritoneal wall behaves like a membrane of parchment. Not only water, but also dissolved substances traverse the membrane in both directions with equal facility, so that after a certain lapse of time the residual glucose solution is found not only to have parted with glucose, but also to have gained from the tissue fluids a very appreciable proportion of sodium chloride.

The phenomenon of one-sided permeability is perhaps nowhere more strikingly illustrated than in the tissues of the kidney which pick out urea from the blood, although present therein in minute concentration, and secrete it into the secretory tubules of the kidney against a relatively enormous osmotic pressure. The epithelium of the kidney is evidently permeable to urea in the direction blood → urine, but under normal conditions must be impermeable or very nearly impermeable to urea in the direction urine → blood. That the one-sided permeability of the kidney is dependent upon the maintenance of the normal structure of the renal epithelium is revealed by its failure in pathological conditions involving partial destruction of the renal epithelium and also by the striking experiment of Bottazzi[3] in which he compared the excretion of the right and left kidneys of the same animal after injury of one of them by sodium fluoride; for while the uninjured kidney secreted urine which was markedly hypertonic in comparison with the blood, the injured kidney secreted urine which was actually hypotonic in comparison with the blood.

It is obvious that the phenomenon of one-sided permeability must be dependent upon a heterogeneous structure of the membrane which displays it. The phenomenon is not and could not be displayed by structureless membranes or by membranes having a uniform structure in the direction of penetration, *i. e.*, perpendicularly to their surface. Nor would any structure of macroscopic dimensions, *i. e.*, involving structural elements of a size far in excess of the mean free path of the molecules, suffice to endow the membranes with this peculiar property. We must therefore seek for the interpretation of the phenomenon in the minute structure of the cell.

A specific arrangement of permeable and relatively impermeable phases of the cell-substance would appear to offer the only reasonable basis for interpretation of the phenomenon. In seeking for constituents of protoplasm which are impermeable or but slightly permeable to the majority of substances dissolved in water the lipoids immediately present themselves as the constituents of the cell most markedly differing from the remainder of the protoplasm in their solubilities and solvent power.

That lipoids are present in abundance in living cells either in combinations of such a character as to mask their micro-chemical properties or in particles so small as to be of very nearly ultramicroscopic dimensions is very strikingly shown by the investigations of Athanasiu,[4] Taylor[5] and others who have shown that the tissues of the liver and other organs in the fatty degeneration induced by phosphorus poisoning do not necessarily contain more and indeed may contain slightly less fat than the corresponding normal tissues. In other words, the fat which is present in the tissues of phosphorized animals in the form of microscopically visible aggregates, is present in the corresponding normal tissues in aggregates too small to be identifiable by staining reactions. The same inference may be drawn from the observation of Gay and Southard[6] that in animals which have experienced anaphylactic shock the gastric epithelium is loaded with visible fat globules, whereas normal gastric epithelium is free from visible fat. In the brief period which elapses between the administration of the foreign protein and death in anaphylactic shock there is no time for transmissal of fat from

[3] Bottazzi, F., *Archivio di Fisiologia*, 1 (1904), p. 273.

[4] Athanasiu, J., *Arch. f. d. ges. physiol.*, 74 (1899), p. 511.

[5] Taylor, A. E., *Jour. of Exper. Med.*, 4 (1899), p. 399.

[6] Gay, F. P., and Southard, E. E., *Jour. of Med. Research*, 16 (1907), p. 143.

one tissue of the body to another. We must assume that the fat in the gastric epithelial cells is present in normal animals in ultramicroscopic or very nearly ultramicroscopic aggregates, and that the circumstances attendant upon anaphylactic shock have merely induced coalescence of the preexisting fat granules into aggregates sufficiently large to be identifiable as fat.

The existence of a considerable proportion of ultramicroscopic fat-granules in living cells which is thus established provides a material basis for the assumption of a diphasic structure in which the one phase is permeable and the other impermeable to substances soluble in water but insoluble or relatively insoluble in fats.

The most usual spatial arrangement of the various structures or constituents of a cell is that of radial symmetry. The primitive arrangement of strictly radial symmetry so frequently displayed in spherical cells becomes modified or distorted in those cells, such as the majority of epithelial cells, which through mutual compression, or for other reasons, have assumed a columnar, stratified or flattened outline. In such cases the radial arrangement of structures may be confined to the sides or margins of the cell or differ in character in the protoplasm underlying the various facets of the cell.

A radial arrangement of the ultramicroscopic fat granules of the cell would obviously lead to the formation upon the surface and in the subjacent protoplasm of minute funnel-shaped pores, of which the interstitial openings would be permeable to substances soluble in water, while the walls, being composed of fat granules, would be impermeable or with difficulty permeable by such substances. The interstitial openings at the margin distal from the center from which the fat granules radiate would be relatively large, while at points lying nearer to the center of radiation, that is, in general, deeper within the cell, even if the radiating lines of globules should not be continued sufficiently far in that direction to actually intersect one another, the diameter of the pores would be very considerably contracted. Substances soluble in water would penetrate such a cell readily, since a relatively large proportion of the cell-surface would consist of the water phase, but they would leave the interior of the cell with difficulty, since a relatively large proportion of the area which they would have to traverse to attain an outlet would consist of the lipoid phase. If the modifications of radial symmetry which are so characteristic of epithelial cells should result in the confinement of this structure to one surface or facet of the cell it is obviously possible that one-sided permeability of a tissue composed of such cells might be the consequence.

It should be borne in mind that the existence of funnel-shaped pores in the surface of a cell or membrane would only give rise to one-sided permeability provided the diameter of the pore at the constricted end were comparable with the mean free path of the penetrating molecules. Were the least diameter of the pores less than the mean free path of a given molecule, then the membrane would be a strictly semipermeable one for this type of molecule; were it, on the contrary, very large in comparison with the mean free path of the molecule concerned, then the membrane would be freely permeable by the molecule in either direction. Thus it is readily conceivable that membranes of this type might exhibit one-sided permeability for certain substances dissolved in water, absolute permeability for others, and semipermeability for yet other molecules.

Any reagent or condition affecting the state of aggregation of the fat globules would necessarily affect the diameter of the pores. In general those conditions involving the formation of large aggregates would increase the permeability of tissue by enlarging the diameter of the radiating droplets and therefore that of the interstitial spaces. Moreover, since the droplets are suspended in a protoplasmic gel, we may infer that in all probability their radial dispersal would be modifiable by alterations of the state of aggregation of the proteins of the cell. The relationship of lipoid solubility and of lipoid solvents and of substances which have a marked effect upon surface tension to the permeability of cells thus find an

intelligible explanation. In the light of the investigations of Clowes[7] and of Fenn[8] upon the influence of inorganic salts upon the state of aggregation of oil emulsions and of proteins in solution it would appear not at all improbable that the striking phenomena of salt-antagonism which Osterhout has shown to depend upon the preservation of minimal cell-permeability, owe their origin to antagonistic alterations of the state of aggregation or displacements of the radial distribution of the lipoid granules of the cell, resulting, when either of the mutually antagonistic salts is present in excess, in enlargement of the interstitial pores.

T. Brailsford Robertson

University of California

THE UTAH ACADEMY OF SCIENCES

The tenth annual convention of the Utah Academy of Sciences was held at Salt Lake City, April 6 and 7, 1917, in the Young Memorial Building.

Four sessions were held beginning as follows: Friday, April 6, at 2 P.M. and again at eight P.M., Saturday, April 7 at 10 A.M. and the closing session at 2 P.M.

President Frank S. Harris occupied the chair at all the sessions.

Dr. Geo. R. Hill, Jr., of the Utah Agricultural College, Dr. Perry G. Snow and Dr. Newton Miller, of the University of Utah, and C. Arthur Smith, of the East High School, Salt Lake City, were elected fellows.

The following were elected to membership: Dr. Orin Tugman, U. U., Professor Walter A. Kerr, U. U., Dr. Frederick S. Pack, U. U., Dr. Joseph F. Merrill, U. U., Professor Elbert D. Thomas, U. U., Mr. James S. Godfrey, U. U., Mr. John W. Sugden, U. U., Dr. Walter D. Bonner, U. U., Professor Hyrum Schneider, U. U., Professor Geo. Coray, U. U., Professor Sherwin Maeser, B. Y. U., Provo, Clarence F. Korstian, Forest Service, Ogden, H. J. Frederick, U. A. C., Professor Clarence J. Sorensen, U. A. C., Logan, Mr. Sidney B. Sperry, Salt Lake City, Mr. L. A. Giddings, East High School, Salt Lake City, Mr. L. Moth Iverson, Salt Lake City, Mr. James W. Jones, Salt Lake City and Mr. Tom Spalding, Provo.

The following are the officers for the ensuing year:

President—W. D. Neal, Salt Lake City.

First Vice-president—Dr. L. L. Daines, U. U., Salt Lake City.

Second Vice-president—Dr. W. E. Carroll, U. A. C., Logan.

Permanent Secretary—A. O. Garrett, East High School, Salt Lake City.

Assistant Secretary—C. Arthur Smith, East High School, Salt Lake City.

Councilors—Dr. Newton Miller, U. U., Salt Lake City; C. Arthur Smith, East High School, Salt Lake City, and Professor Carl Eyring, B. Y. U., Provo.

The following papers and lectures were presented:

"The Pressure-watt Characteristics of Drawn Wire Tungsten Lamps," by C. Arthur Smith, East High School, Salt Lake City.

"The Variation of the Electric Conductivity of Thin Metal Films," by Dr. Orin Tugman, U. U., Salt Lake City.

"The Anastomosing of Arteries and Veins in a Family of Cats," by Dr. Newton Miller and Mr. James Godfrey, U. U. (Paper presented by Mr. Godfrey.)

"Preformation in Modern Science," by Dr. Newton Miller.

"The World without Science" (presidential address), by Dr. Frank S. Harris, U. A. C.

"The Value of Scientific Research in Forestry," by Mr. Clarence F. Korstian, Forest Service, Ogden.

"Comparative Essay on some Birds of Europe and North America," by L. Moth Iverson, Salt Lake City.

"The Effectiveness of the Corrosive Sublimate Treatment of Potatoes," by Mr. Bert L. Richards and Dr. Geo. R. Hill, Jr., U. A. C. (Paper presented by Dr. Hill.)

"Factors affecting the Planting of Various Crops," by Howard J. Maughan, U. A. C.

"Freezing Temperatures in Fruit Buds," by Dr. Frank L. West, U. A. C.

"Sugar Beet Syrup for Young Pigs," by Dr. W. E. Carroll, U. A. C.

"The Present Situation of Rabies in the State," by Dr. L. L. Daines, U. U.

"The Time Element in Voluntary Control," by Dr. Geo. S. Snoddy, U. U.

"The Liquid Sulfur-dioxid Method of determining Aromatic Hydrocarbon Oils," by Mr. Joseph, U. U.

"The Destructive Distillation of Gilsonite," by Mr. Erickson, U. U.

A. O. Garrett,
Permanent Secretary.

[7] Clowes, G. H. A., *Journal of Physical Chemistry*, 20 (1916), p. 407.

[8] Fenn., W. O., *Proc. Nat. Acad. of Sciences*, Washington, 2 (1916), pp. 534 and 539.

SCIENCE

Friday, June 8, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE DERIVATION OF ORBITS, THEORY AND PRACTISE[1]

Less than twenty-five years ago it was commonly accepted among astronomers and mathematicians alike that the orbit problem had been solved both in theory and in practise. Without detailing the well-known history of the development of orbit methods before that time it is sufficient to remind you that although Newton, after successfully integrating the differential equations in the problem of two bodies and verifying Kepler's laws, proposed a geometrical method which was successfully applied by Halley particularly in determining the orbit of the well-known comet which bears his name, the integrals derived by Newton were not translated into a thoroughly practical method for determining the constants or elements from the initial conditions furnished by observation until 1797 when Olbers published his famous method of determining parabolic orbits for comets from three observed positions. This special method was followed at the dawn of the last century by the general method of Gauss which permits of the determination of the elements from three observations without previous hypothesis regarding the eccentricity, a method applicable equally to comets and to planets. It is to be noted that both Olbers's and Gauss's methods rest on the previous analytical solution by Newton of the equations of motion in the two-

[1] **Address of the vice-president and chairman of Section A, American Association for the Advancement of Science, read at a joint meeting of Section A, the American Mathematical Society and the American Astronomical Society, on Thursday, December 28, 1917, at New York.**

body problem. In fact these orbit methods may be characterized as an evaluation of the numerical values of the constants or elements from given positions on the basis of the integrals found by Newton. It might be supposed that the mere evaluation of the numerical values of the constants of integration in a given case when the form of the integrals is known ought not to involve any considerable difficulties. But the solution of the unknown elements from the given equations of condition leads to very complicated expressions which can be solved only by successive approximations. This unfavorable condition arises from the occurrence of series in which the coefficients depend upon the unknown elements. Until the early nineties of the last century the chief aim of astronomers and mathematicians had been to modify the methods of Olbers and Gauss by transformations which would increase the degree of accuracy of the first and the convergence of later approximations. The most successful orbit methods would then be those which would yield the elements with the greatest degree of accuracy and with the minimum of numerical work.

The observations in general furnish three directions of three heliocentric positions of the body, each seen from one of three different positions of the observer. The problem of the older methods is to pass a plane through the center of the sun which cuts the three directions in such a manner that the body moves in accordance with the law of areas in the conic, which is defined by the three intersections of the plane with the directions, and by the center of the sun. It is evident at once that if the three directions are taken at short intervals they must be given with the utmost precision so that the parameters of the conic may be determined with any degree of accuracy.

In general a very large number of planes satisfying the required conditions may be drawn within the unavoidable errors of observation, so that every preliminary orbit is more or less indeterminate. Thus while a perfect theory might be available for the evaluation of the elements, in practise the numerical accuracy of the orbit will be limited. This limitation of accuracy in general increases with the ratio of the errors of observation to observed motion. In addition, even with perfect observations distributed over a sufficiently long heliocentric arc, cases occur in which the mathematical expressions for the solution of the elements lead to indeterminate forms. In some cases these indeterminate forms are inherent in the physical conditions of the problem. In other cases they may be avoided by proper mathematical devices or by a different mathematical treatment of the problem. One of the best known cases of indeterminateness arising from physical conditions is that in which the orbit plane coincides with the ecliptic. In this case the position of the orbit plane, usually defined by two elements, is given at once, but since each of the three observed directions furnishes but one independent condition, namely the longitude, while four elements remain to be found, the problem becomes indeterminate and requires a fourth observation for its solution. One of the best known cases of the other type of indeterminateness arising from the mathematical formulation of the orbit method is the so-called Ausnahmefall (exceptional case) of Oppolzer in Olbers's parabolic method. When the orbit is supposed to be parabolic only five elements need to be determined from the six conditions furnished by observation. The observed direction is usually given in right ascension and declination and may be considered as the intersection of two planes which may be introduced as given condi-

tions. Since the choice of these planes is arbitrary, as long as their intersection coincides with the line of sight Olbers reduces the number of available conditions by rejecting one of the arbitrary planes for the middle place or second observation and adopts for the other arbitrary plane that which corresponds to a great circle drawn through the observed place of the body and through the sun.

Since the three distances of the body are not furnished by observation they enter the problem as additional unknowns. Usually the distances are derived first, whereupon the solution of the elements becomes comparatively simple. In Olbers's method one of the fundamental relations for the determination of the distances at the first and third dates has the form $\rho_{III}=M\rho_{I}$, where M is equal to the product of the ratio of two triangular areas into the ratio of the trigonometrical sines of the perpendicular arcs drawn from the first and third observed places, respectively, to the great circle through the sun and the second observed place. The ratios of the triangles referred to form a very important consideration in many orbit methods. The triangles are contained between successive radii vectores from the sun to the body. For short arcs or intervals these triangles differ but little from the corresponding sectors bounded by the conic, and since according to the law of areas the sectors are proportional to the intervals, the triangles are very nearly proportional to the intervals. The ratios of the triangles may then be developed in series of which the first term is identical with the ratio of the intervals and of which the later terms contain the powers and products of the intervals, the inverse powers of the heliocentric distances r and their derivatives. They may be made to depend on the second heliocentric distance r and its derivatives. Since r and its derivatives depend on the elements in the orbit their values in general can not be known until the first approximation has been accomplished by placing the ratios of the triangles equal to the ratio of the intervals. The series representing the ratios of the triangles have been the subject of intensive study in connection with the orbit methods resting on the integrals of Newton. The most exhaustive study of the true radii of convergence of series of this type is due to Moulton. He demonstrates analytically the empirical conclusions of astronomers that the series may lose their applicability for comets observed near perihelion at a moderate distance from the sun, while for minor planets in general they give universal satisfaction.

In referring to the indeterminateness in Olbers's method I am not at this moment concerned with any inaccuracies that may arise from his using in the first approximation the ratios of the intervals for the ratios of triangles. The indeterminateness I am referring to arises from the fact that when the first and third observed positions lie on the auxiliary great circle through the second place and the sun, referred to above as being introduced by Olbers, then both the perpendiculars from the first and third places on this great circle become zero and M becomes indeterminate. It becomes nearly indeterminate when the three observations lie approximately in the great circle through the sun, and the degree of indeterminateness in such cases depends upon the magnitude of the errors of observation as compared with the magnitude of the perpendiculars. It is evident that perpendiculars of but a few seconds accurately derived from precise observations would still yield a working first approximation, while larger perpendiculars comparable to the errors of observation would lead to fallacies or yield nothing. Here

we have a significant contrast of the interpretations with reference to accuracy obtainable from theory and practise. Theoretically small perpendiculars in Olbers's method would lead to indeterminateness, but in practise it is not the absolute magnitude of the small perpendiculars that counts so much as their uncertainty due to errors of observation. To return once more to Olbers's method, when his mathematical formulation leads to a practical indeterminateness the difficulty may be removed at once by substituting for Olbers's great circle through the second place and the sun a great circle perpendicular to it. This choice of great circle evidently produces a maximum value of the perpendiculars drawn to it from the first and third places, so that the effect of the errors of observation is minimized.

It must not be supposed that the conditions of indeterminateness just referred to were not known to theoretical astronomers until recent times. In his classic "Lehrbuch zur Bahnbestimmung," the second edition of which was published in 1882, Oppolzer sets forth clearly and concisely the significance of errors of observation with reference to small quantities which are theoretically of a high order of smallness, when the intervals or motion are considered quantities of the first order. My own aim and that of those associated with me at the University of California has been to treat each case on its own merits from the numerical point of view and to ascertain at the outset the uncertainty which must necessarily remain in the result. As this uncertainty corresponds to a region of possible numerical results clustering around the physical solution or in case of multiple mathematical solutions around these, all of which correspond to orbits that will satisfy the observations within their errors, I introduced the term *range of practical solutions* in a paper read at the International Congress of Arts and Sciences at St. Louis in September, 1904, and have at the same time and again later set forth the numerical conditions producing a range of practical solutions. In the modifications of the formulæ, for computing orbits so as to secure the greatest accuracy with the least expenditure of numerical work this principle has been constantly borne in mind. I emphasize this point because this distinction between practise and theory has not been well understood. Moulton, in a very exhaustive memoir on the "Theory of Determining Orbits," published in the *Astronomical Journal* in 1914, to which further reference will be made later, also seems to have failed to recognize the significance of our work in this regard, although it was set forth in detail in another form in Buchholz's "Klinkerfues Theoretische Astronomie," third edition, 1912, which Moulton has reviewed. In the first example published in this work I was careful to place a dot over the last digit of every fundamental quantity that could be relied upon.

To facilitate our further discussion it may be well to trace in outline the fundamental principles of the methods of Olbers and Gauss as set forth by Oppolzer in a masterly manner. Olbers's and Oppolzer's parabolic methods yield a solution of the first and third geocentric distances from the equation $\rho_{\text{III}} = M\rho_{\text{I}} + m$ and the well-known Euler's equation expressing the intervals between the first and third dates in terms of the sums of the radii vectores drawn from the sun to the first and third places and the chord joining these two places. With Olbers's choice of the great circle through the middle place m becomes zero. In both methods the ratios of the triangles are replaced in the first approximation by the ratios of the intervals. Even

then the solution is accomplished only by successive approximations or trials in the course of which, however, higher terms of the series in the ratios of the triangles may be taken into account. It is customary to assume as a first approximation that the sum of the first and third radii vectores is equal to 2 astronomical units. Convergence of the approximations has been facilitated by Oppolzer by differential relations which give the correction to be applied to the initial value of $r_I + r_{III}$ so that it may agree with the value derived at the end of the trial. In the course of ordinary trials without the use of differential relations the final values of the distances of one trial form the initial values in the next trial. In the method of differential corrections such corrections to the initial value of one trial are derived differentially from the differences between the initial and final values in the same trial as will produce an agreement of the initial and final values in the next trial. The number of approximations required by the ordinary trials is in general far in excess of that required by the method of differential correction.

Gauss's method as formulated by Oppolzer may be started from the equation $Ax + By + Cz = 0$, which expresses that the body moves in a plane through the sun, x, y, z being the heliocentric rectangular coordinates referred to the sun. When this equation is written out for each of the three places and when the eliminant of the three equations is written down in the form of a determinant this determinant may be developed either in terms of co-factors of the x, or the y, or the z. For instance, in co-factors of x we have

$$x_I(y_{II}z_{III} - y_{III}z_{II}) - x_{II}(y_Iz_{III} - y_{III}z_I) + x_{III}(y_Iz_{II} - y_{II}z_I) = 0.$$

The coefficients of x here represent the projections of double the triangular areas $[r_i\ r_j]$ upon the yz plane. By dividing out by one of these areas the two resulting coefficients represent the ratios of the projected triangles and since the triangles are projected on the same plane these ratios are the same as the ratios of the triangles themselves. As stated before, instead of developing the determinant by co-factors of x it may also be developed by co-factors of y and z. We thereby obtain the same equation written in two additional forms. Every equation is identically equal to zero, if the terms are multiplied out. But if we can assume the numerical values of the ratios of the triangles to be known from other sources and if we express in each of the three equations the heliocentric rectangular coordinates in terms of the geocentric polar coordinates and of the solar coordinates so that, for instance,

$$\frac{[r_{II}r_{III}]}{[r_Ir_{III}]}(\rho_I \cos\alpha_I \cos\delta_I - X_I) - (\rho_{II}\cos\alpha_{II}\cos\delta_{II} - X_{II}) + \frac{[r_Ir_{II}]}{[r_Ir_{III}]}(\rho_{III}\cos\alpha_{III}\cos\delta_{III} - X_{III}),$$

then we arrive at three equations with the geocentric distances as unknown quantities. Now if the ratios of the triangles could be known at the outset, it is evident that the geocentric distances can be obtained by the solution of these three equations. The first approximation, depending upon the degree of accuracy with which the ratios of the triangles are introduced, is generally referred to as the first hypothesis and the accuracy of the geocentric distances and therefore of the whole solution which depends upon them is referred to as being of the zero, first, or higher order with reference to the intervals or motions. The choice of equal intervals always increases the accuracy by one order. Simple as this process seems in theory, it becomes very complicated in practise, because in general a first approximation can not be obtained by merely using the ratios of the intervals as numerical expressions for the ratios of

the triangles. It is necessary to introduce at the outset one or more of the terms involving the inverse powers of the heliocentric distance r and its derivatives, and these can not be known until the geocentric distances have been obtained, r being derived from the triangle which has at its vertices the observer, the sun, and the body. The angle at the observer is known by observation, the distance of the sun from the earth is known, and ρ being assumed, r may be found. But since neither r nor ρ is known at the outset, the solution must be accomplished by trial and error. Here, as before, the method of differentially correcting the first approximation on the basis of the difference between initial and final values in a trial is very effective. Thus the first hypothesis involves a series of trials for the solution of r and ρ, and it is accurate to zero, first, or second order, and so forth, according to the number of terms in the ratios of the triangles introduced in the first set of trials for the distances, which trials become, of course, the more complicated, the more terms are introduced. A practical limit is thus set at once. The second hypothesis depends upon the computation of the remaining terms of the series in the ratios of the triangles on the basis of values derived from the first hypothesis. While these values may be sufficient for the higher terms the lower terms taken into account in the first hypothesis still remain inaccurate since they do not contain the final numerical values of the unknowns. This is important because it involves successive resubstitution of the improved values in all terms of the series. We shall see later that these complicated manipulations have recently been removed by Charlier by completing a purely analytical solution proposed by Lagrange. In passing from one hypothesis to the next it is necessary, as previously stated, to calculate the remaining terms of the series representing the ratios of triangles. Oppolzer ingeniously computes the whole remainder in a closed form, but in determining the numerical value of the closed remainder must perform successive approximations, as I say, merely to get the remainder. These approximations involve the complicated expression of the ratio of a sector of a conic to the corresponding triangle. Thus we see that in Oppolzer's formulation, which is the most accurate yet proposed, it is necessary first: to undertake several hypotheses; secondly: within each hypothesis to perform a number of trials for the distances; and, thirdly: in passing from one hypothesis to the next to perform approximations involving the ratio of sector to triangle. The application of the method of differential correction, so successfully applied in the trials for the distances, in place of these several cycles will take up in one operation all of these cycles of approximation as will be referred to later.

It is not necessary to go into the various and numerous devices which have been proposed during the past century to facilitate the various cycles of approximation referred to. Be it sufficient to say that the highest degree of accuracy has been obtained in this country by Gibbs in his vector method, which in the first hypothesis takes account of terms of the fourth order in the ratios of the triangles. But although this method is the most accurate of all the so-called methods in the first hypothesis it unfortunately requires too large an amount of numerical work in the first approximation and does not readily lend itself for application to a second hypothesis. It has, therefore, failed to come into universal use.

I have already referred to the methods hitherto described as "the older methods." They have been set down in various excellent formulations, particularly by Klinker-

fues, by Watson in this country, by Oppolzer, by Buchholz, by Tisserand, and others, and are in use to the present day in accordance with the various formulations, but unfortunately without being duly appreciated in all cases by computers with reference to their numerical significance, that is, with reference to the validity of the results which they produce as conditioned by partial indeterminateness or range of practical solutions. Furthermore, to cite from my paper on "Preliminary Statistics on the Eccentricities of Comet Orbits":

> Ever since the first computation of a comet orbit was made, it has been customary to derive a parabola as a first approximation, and to attempt a more general solution only if the deviations of the observed positions from the most probable parabola were in excess of the probable errors of observation. This custom has become so thoroughly fixed in astronomy that even now it would be considered absolutely unwarranted to suspect a comet of moving in an ellipse if by a little stretching of the probable limits of observational error a parabola could be found to represent the observed positions. A prejudice has always existed and exists now in favor of the parabola for comets. This prejudice is largely due to the many published parabolic comet orbits. A further reason lies in the fact that the first geometrical and analytical methods for solving a comet orbit were parabolic. The solution of an elliptic orbit was originally possible only in cases like Halley's comet, in which more than one appearance had been observed so that one of the unknowns, the period, became known.

The procedures in the older methods for the derivation of a parabolic and the derivation of a general solution are so different that when it is recognized that a parabolic orbit or conditioned solution is not possible, a fact which does not reveal itself until after many fruitless attempts at a parabolic solution have been made, it is necessary to discard most of the previous numerical work and to start anew with the formulæ for a general solution. An illustration of the labor involved in this antiquated process is furnished by the published work of one of the leading European astronomers on the preliminary orbit of comet 1892 II. (Holmes). Three observations at equal intervals of four days were available in this case. The computer attempted a parabola and, finding that he could do nothing with the ratios of the triangles in improving his orbit, finally resorted to an arbitrary variation of M referred to in Olbers's method as the ratio of the third to the first geocentric distance, thus producing four different parabolic orbits with ephemerides from which to choose, none of which admittedly represented the given observations. Only later and still greater discrepancies between observation and the predicted path lead the computer to resume the computation without hypothesis regarding the eccentricity. In due course of time this general solution yielded a short period ellipse. Here is a bit of practise still in use among many computers which, if applied in the business world, would involve an enormous cost of operation. Mr. Shane, one of my students, applied my formulation of the Laplacean method to this case and obtained the true ellipse in the first approximation or by a direct solution without difficulty in a few hours.

Nor is it always safe to assume the nature of the object and the character of its orbit from its appearance. Thus some comets are of a star-like appearance when discovered and can not be distinguished from asteroids, and to prejudice the character of the orbit at the outset may lead to unnecessary complications. It is not improbable that some of the short periodic orbits published for supposed minor planets which have become lost are really very eccentric orbits of comets which would account for their failing to be reobserved in their predicted places. Just how many of the published orbits of the hundreds of planets and comets are entirely reliable is

difficult to say until a thorough examination shall have been made of the range of practical solution for each case. When a planet or comet has been observed for a considerable length of time, or on several returns, the elements require no further examination if they have been properly corrected on the basis of the observational material. But the comet and planet lists are full of orbits based upon comparatively short arcs and the lists contain little indication of the degree of accuracy in each case.

Sometimes when physical and mathematical indeterminateness does not prevail the range of solution with precise observations is quite limited even for a very short arc, and the resulting orbit is fairly accurate. In other cases conditions may be such that even for a comparatively long arc the orbit is inadequate to secure rediscovery at a later return. Comet *e* 1913 Neujmin was of a star-like appearance and admitted of a high degree of accuracy in the observed positions. The first three observations at one-day intervals admitted of the determination of a periodic orbit agreeing closely with a more accurate orbit determined from a 38-day arc. On the other hand, orbits of planet (702) discovered in 1910 based on arcs of several months show a wide range of practical solution amounting to about four degrees in the eccentricity.

An accurate knowledge of the eccentricities of comet orbits is of importance in determining the origin of comets. On theoretical grounds it has long been recognized that parabolic orbits are practically impossible if comets came from without the solar system, formerly a favorite theory of astronomers. The majority of orbits should be elliptic if comets have their origin within the solar system. A rare parabola and some hyperbolas might, of course, be accounted for through the perturbations of the major planets on an original ellipse. But if comets came from without they should be predominatingly hyperbolic. Now the published comet lists show that about three fourths of all comet orbits have been found to be parabolic. A study of the published eccentricities of comet orbits on the basis of the accuracy with which, and the length of time during which they were observed has shown conclusively that all comet orbits are elliptic if observed with sufficient accuracy and for a sufficient length of time. This conclusion was received with doubt when I first announced it in 1907 on the basis of a study of the eccentricities of comet orbits. That three fourths of the comet orbits are parabolic is due to the fact that comet orbits in general have a high eccentricity and that the parabola lies within the range of possible solutions. Since the lower limit of the eccentricity has never been sought the orbits have simply been set down as parabolic and much confusion has been created with reference to the determination of the origin of comets. A few well-determined hyperbolas do exist, but Stroemgren has shown that these are accounted for by perturbations of the original ellipses on the part of the major planets. The high eccentricity found for comet orbits lies in the nature of things. Long-period comets can not come within the range of visibility from the earth unless their orbits are highly eccentric. The others must remain invisible. It is only within recent years that the old idea that comets are visitors from without the solar system has been abandoned. Reference to the existing confusion in regard to the origin of comets is made here only because it is clear that if in the past astronomers had worked by methods which readily enable the computer to ascertain the range of possible solutions, particularly the lower limit, three fourths of all

comet orbits would not have been set down as being parabolic and much analytical work with reference to the origin of comets would have been avoided. Yet there is a practical advantage in adopting a preliminary parabolic solution for a comet when the range of solutions is very large and when this range includes the parabola. For since the majority of comet orbits have high eccentricities the adoption of a preliminary short-period orbit would later involve a more radical correction than the adoption of a preliminary parabola. Of course within the physical indeterminateness or the practical range of solutions any and all of the orbits satisfying the observations within their errors are equally justified, but even to this day it is a reflection on the astronomer if the period or eccentricity of his preliminary orbit must be increased to satisfy later observations, while it is quite the proper thing to publish a parabola and later to find the orbit short period even if such short period and eccentricity could have been derived at the outset. Thus in the case of comet Neujmin referred to above parabolic orbits were still insisted upon, while the comet closely followed our short-period orbit from a two-day arc. It has been my frequent experience that elliptic orbits with a fair degree of accuracy could be determined from the first three observations, while other computers continued to produce parabolas which could be shown not to lie within the range of solution and resulted from the use of approximate methods.

In anticipation of stating the many advantages introduced by the modernization of the method originally proposed by Laplace I have already dwelt on three important considerations, namely, first, on the complications involved in the successive hypotheses and approximations of the older methods; secondly, on the waste of time in applying different formulas for a conditioned and a general solution so that with the abandonment of a parabola it is necessary to make a new start; and thirdly, on the significance of the range of solution as derived from partial indeterminateness depending upon the shortness of the arc and upon the effect of error of observation on small significant coefficients. My own attention was directed to Laplace's method by a memoir of Harzer. Laplace's method appeared in 1780 in a memoir and later in his Mécanique Céleste. Prior to him, in 1771, Lambert had produced his famous theorem based on geometrical considerations. Later, in 1778 Lagrange showed that Lambert's equation leads to an equation of the seventh degree, the fundamental equation of the orbit problem which also occurs in the older methods and which Charlier proposes to designate as Lagrange's equation. Laplace and Lagrange mutually inspired each other to further important developments of the orbit problem. Laplace starts with the three differential equations of motion of the second order for the two-body problem under the Newtonian law of attraction as applied to the motion of a material point (the object) about the sun. He then expresses the heliocentric rectangular coordinates of the object in terms of its geocentric coordinates and the heliocentric coordinates of the earth. The rectangular coordinates are then replaced in terms of polar coordinates, and thereby three equations are derived which give the geocentric distance ρ, its velocity ρ', and its acceleration ρ'' at the epoch in terms of the observed coordinates (for which we may choose α and δ, their velocities (α' δ'), and their acceleration (α'', δ''), and also in terms of the unknown heliocentric distance r of the object and known quantities, depending upon the motion of the earth about the sun.

If, therefore, for the present, we assume the coordinates α, δ, their velocities α', δ', and their accelerations α'', δ'' to be known, we have three fundamental equations for the solution of the four unknowns ρ, ρ', ρ'', and r. The fourth equation is derived from the triangle sun-earth-object, and involves ρ, r, and known quantities. By elimination the problem reduces to Lagrange's equation of the seventh degree with not more than two positive real roots, which may be interpolated to six decimals from a table which I have prepared for this purpose, so that the solution may be accomplished without the hitherto necessary laborious numerical approximations.

The direct solution which has just been outlined corresponds to the so-called first hypothesis of other methods. It is evident that the accuracy of Laplace's direct solution depends upon the accuracy of the fundamental observational data for which we have chosen α, δ, α', δ', α'', δ''. If the epoch is chosen to coincide with the date of one of the observations, then α, δ are fixed numbers, and the accuracy of the Laplacean solution depends upon the accuracy of the adopted values of their velocities and accelerations or, which is an equivalent statement, upon the accuracy of their first and second differential coefficients. In practically all other methods the accuracy of the solution depends upon the accuracy of the adopted values of the ratios of the triangles. Unfortunately the method of Laplace has been prejudiced by Lagrange until recent times through a letter addressed to Laplace, in which he says that while analytically Laplace's method constitutes the simplest solution of the problem, in practise it does not afford corresponding advantages because the differential coefficients could not be determined with the necessary accuracy. This far-reaching statement Lagrange intended as a mere opinion which he proposed to verify later by mathematical demonstration. It is a remarkable fact that Lagrange's opinion, although never verified by himself, has been the chief cause of retarding the further development of the Laplacean method until recent times.

Nevertheless, several attempts at giving it a practical formulation have been made during the last century, but with indifferent success. With reference to the disrepute which Laplace's method and all formulations based upon the same have been held until recent times and for a statement of its actual merits I may refer you to my address delivered before the International Congress of Mathematicians in August, 1912. Laplace's method leads to the usual equation of the seventh degree, which, as stated above, we shall refer to as Lagrange's equation. The roots of this equation have been frequently studied by Cauchy, Mrs. Young (Grace Chisholm), Oppolzer, and others. In recent times a classic study of the equation has been published by Charlier, who not only clarifies the existing conditions which will lead to a multiple solution, but exhibits these conditions geometrically by dividing space into four regions symmetrical with reference to the line joining the earth and sun as central axis, and showing that two solutions exist when the body is in two of these regions, and one solution when the body is in the other two. In certain cases it is not possible to distinguish the mathematical from the physical solutions, so that either a fourth observation must be employed in the original solution or the mathematical solution must be eliminated on the basis of difference between theory and later observation.

My own formulations of Laplace's method need be referred to but briefly. The results are chiefly that the whole process has

been extremely simplified. A conditioned solution may be made on practically the same plan as a general solution. Criteria have been introduced to distinguish between the feasibility of solution with or without assumption regarding the eccentricity. Provision has been made for passing from one class of orbit to another in the course of the computation without repeating the solution. Numerical criteria have been set up to distinguish the physical from the mathematical solutions in the case of three roots which may occur in the parabolic method. A method has been provided for completely eliminating the paralax, as has been done in the case of Planet *MT* by Dr. E. S. Haynes, since in this case the possibility of a solution rested on such elimination. The various approximations for the solution of distances is avoided. In a general solution the distances are taken from a table. The accuracy attainable in each case can be ascertained in advance and the range of solution definitely determined. Series corresponding to the ratios of the triangles, which do not enter, however, in the original solution but only later after the distances have been determined, have been replaced by closed expressions which avoid slow convergence or divergence in case of comet orbits observed near perihelion and at a moderate distance from the sun. The whole cycle of hypotheses and approximations of the older methods and all initial inaccuracies are taken up by a method of differential correction. In the case of highly disturbed satellites, such as the ninth satellite of Jupiter, the orbit solution has been made possible by extending the formula so as to take account of the perturbations in the first approximation. Closed expressions in the differential correction of an orbit now make it possible to apply the method to any and all conditions, particularly to arcs of any length.

It is not possible to dwell further on these advantages, yet reference may be made to some important results which make unnecessary extensive investigations hitherto in use. In the case of comet 1910*a*, which was discovered near perihelion and at a moderate distance from the sun, a variety of preliminary orbits were derived by various computers. Through the work of Oppolzer, Charlier, and myself, it was already known that cases of three mathematical solutions might be possible. Tscherny classified all the different preliminary orbits that had been derived for this comet and showed that clearly they represented three groups, each group representing a range of solution clustering about a mathematical solution. Each computer had produced a perfectly legitimate orbit within the errors of observation, none recognizing that his orbit was one belonging to one of the three ranges, or that multiple solutions existed. In my short methods simple criteria are given for determining the existence of three mathematical solutions of the equation of the sixth degree for a parabola. As soon as observations became available the method was applied by Miss Levy and three distinct values of the geocentric distance at the middle date and the range of each were obtained. A simple consideration leads to the elimination of the two fictitious parabolic solutions, as there can be at most two general solutions, also either one or three parabolic solutions, and as only one parabolic solution can agree with a general solution. By this process the physical solution was at once determined. The two general solutions corresponding to the problem are readily taken from the table so that all five roots, two general and three parabolic, are available simultaneously and with little effort. Therefore, there really exists no reason why hereafter a computer should ever be

misled to derive a parabola corresponding to a solution other than the physical solution. By the method of the greatest common divisor Picard has reduced the equations for general and parabolic orbits to a linear equation giving the only possible parabolic solution.

The other point on which I desire to dwell is that of the identification of newly discovered planets or comets with objects previously observed and for which orbits are available. More than once it has been found in the case of a newly discovered comet that the inclination, node, and perihelion distance of the parabolic solution resemble within the range of the solution the corresponding elements of some former parabolic comet. By introducing a period corresponding to one or more revolutions between the dates of the perihelia of the two comets the original solution may be turned into a conditioned solution based on a definite period. In no case where definite reasons for such procedure existed did this experiment fail of proving the identity of two comets. Thereby the two objects instead of being different comets with parabolic orbits were recognized to represent a single comet, moving in a definite ellipse. It is quite probable that a proper study of the existing comet lists may readily lead to many identifications. Many pretty results might be cited in connection with the various advantages to which I have referred above as obtainable from a proper formulation of Laplace's method. Undoubtedly there are cases where Gauss's and Olbers's methods would converge more rapidly than my own formulation of Laplace's method, but these are readily ascertained at the outset. Orbits have been computed at Berkeley for practically every comet since the methods have been perfected, and so far every case has readily yielded to a solution.

In recent times notable memoirs have been written on orbit theory by Harzer, Charlier, and Moulton. I have not as yet had an opportunity to study Harzer's new geometrical methods with respect to their practical value. With the claims made in Moulton's memoir on the "Theory of Determining Orbits," published in the *Astronomical Journal* in 1914, I can not, unfortunately, find myself entirely in accord. The object of the memoir is set forth to be, on the one hand, to clarify the problem mathematically, and, on the other, to define the extent of the indeterminateness. In spite of the noted mathematical skill of Moulton it appears that although his forms have the merit of symmetry, his treatment of the problem which involves determinants of the ninth order, though readily reduced, offers no advantages over the simplifications arising from earlier combinations of geometrical and dynamical relations. To his misconception of the practise of the computers at Berkeley, with reference to the interpretation of the accuracy of their results, I have already referred. These misconceptions apply also to the significance of a number of theoretical and practical points, particularly to his interpretation of the vanishing of the chief determinant. Quite contrary to his statement in his "Celestial Mechanics" that in general the expressions for ρ and ρ' become indeterminate when the determinant referred to is zero and that they are poorly determined when it is small, it may be shown that the orbit is in general well determined when the determinant is definitely zero or definitely small, and that the determinateness of the solution does not depend so much on the numerical value of the determinant, but upon the accuracy with which this numerical value can be found. Thus a large range of solution may result for a comparatively large value of the determinant, if

that value has a large percentage error. These conditions have been partially set forth in Buchholz's "Klinkerfues Theoretische Astronomie," but reference has been made by Moulton only to the first and initial draft of the methods as published in 1902. It is, of course, not my intention at this time to undertake a detailed analysis of Moulton's memoir. This must be deferred to some more appropriate time and must be done in more explicit form. With reference to the formulation finally adopted by Moulton it may readily be shown that it reverts to Gauss's method.

The most notable and classic contributions to the orbit theory in recent years have been made by Charlier. In a number of memoirs he has set forth the fundamental principles of the problem and has thrown much light on the subject with reference to many details, but his most important contribution is the resumption of Lagrange's incomplete analytical solution, a pure analytical solution in series, which admits of determination of the higher terms by direct computation without involving successive approximations of any kind nor requiring an improvement of the lower terms. His theoretical developments hold out the highest promise of successfully conquering the problem in practise without the complications existing in the older methods. But at present serious practical difficulties still exist, chief among which is that the series involved become extremely complicated when a high degree of accuracy is required, and that the method is subject to several of the limitations of the older methods. If these complications and limitations can be removed the method will be the best in existence. One of the chief limitations affecting practise consists in the fact that it is a general method and that it therefore may lead to orbits within the range of solution which are not acceptable from experience. It has been applied to the computation of several planet and comet orbits by Charlier and his associates. In the case of Comet e 1906 the resulting orbit is an hyperbola with an eccentricity 1.46. This seems to represent a solution near the upper edge of the range. A parabolic solution has been produced from the observations without difficulty in the first approximation by my formulation of Laplace's method by Miss Levy. In the case of another comet the elements are slightly hyperbolic; in the case of planet (702) the orbit deduced by the Charlier-Legrange method from an arc of two months gives an angle of eccentricity differing by nearly four degrees from the corresponding angle deduced near the upper possible limit by Miss Levy. Under these circumstances it would be difficult to decide where to stop in the computation of the terms of his series in relation to the possible range of solution.

From the somewhat disconnected and incomplete observations which I have just made on the methods of determining orbits it is seen that the interest of investigators is directed along two distinct lines, purely mathematical and practical. A proper adjustment between the two is required by the demands of astronomical science. In this connection and in conclusion I may make reference to the possibility of determining the orbit of a highly disturbed satellite from a limited number of observations on the basis of Laplacean principles. It is not necessary to await the evaluation of all the 18 integrals of the problem of three bodies for the purpose of setting up a satisfactory orbit method. Laplace's method for the two-body case is not based on Newton's integrals, but by introducing numerical values for the geocentric velocities and accelerations in α and δ the differential equations are

transformed into algebraic equations admitting of easy solution of r, ρ, its velocity and acceleration. This equation has been found to be of the seventh degree or of the eighth if the always existing root ρ equal zero be included. My equation for three bodies, that is, for the solution of orbits of disturbed bodies, is of the twenty-eighth degree and admits at most of three solutions, the examination of which makes it possible to decide whether a body is a satellite, planet, or comet, in cases where the physical appearance of the object does not settle this question in advance.

In spite of the extensive investigations that have been made on the orbit problem there is room for much improvement both in theory and in practise, improvement which can not fail to come through proper cooperation of astronomers and mathematicians.

A. O. Leuschner

University of California

SCIENTIFIC EVENTS

THIRD INTERSTATE CEREAL CONFERENCE

An executive committee, representing the U. S. Department of Agriculture and state experiment stations, has called a third interstate cereal conference to be held at Kansas City, Coates Hotel, June 12–14. This conference, which has the approval of the Secretary of Agriculture and the directors of the state stations, is for the purpose of discussing questions involved in and work essential to accomplish the enlargement of cereal production and the economic utilization of cereals during the existing war emergency. In addition to the representatives of the institutions mentioned, the flour mills, grain inspection departments, grain dealers and manufacturers of cereal foods and corn products of the grain states are invited to send delegates. Some of the subjects to be discussed are:

Agricultural War Measures in Kansas.
Waste in Cereal Production on the Farm.
The Importance of Good Seed.
The Proportion of Flour and By-products in Milling.
The Preparation of Land for Wheat.
The Use of Barley as a Food.
Corn as a War Crop.
Treatment of Seed Grain for the Prevention of Smuts.
Analysis of the World's Wheat Supply.
The Importance of Grain Sorghums.
Federal Standards for the Grading of Wheat.
Weed Seeds in Relation to Grain Grading.
The Importance of Testing Spring Wheat for Germination.
The Next Step in Improvement in Wheat Cropping.
The Work of Committee on Seed Stocks, U. S. Department of Agriculture.

The delegates to the conference are invited to Manhattan, Kansas, on June 15, to inspect the cereal field work of the Kansas Agricultural Experiment Station.

Charles E. Chambliss,
Secretary

U. S. Department of Agriculture,
Washington, D. C.

THE SOCIETY OF INDUSTRIAL ENGINEERS

The Society of Industrial Engineers, a national organization, the membership of which is to comprise men and women who are industrial engineers, professional technical engineers, accountants, managing executives of commercial and industrial activity, writers, educators and students, was planned in Chicago on May 26. The Society will be permanently organized in Washington, on June 15, on which date the directors have been called to meet.

Charles Buxton Going, for twenty years editor of the *Engineering Magazine*, New York, was chosen provisional President and *pro tem* chairman of the board of directors which was chosen at the session. This board, comprising 15 prominent men from various sections of the United States, the majority of whom have accepted, includes:

Charles Buxton Going, New York; C. E. Knoeppel, industrial engineer and organization counsel, New York; Frank B. Gilbreth, industrial engineer, Providence, R. I.; E. C. Shaw, vice-president The B. F. Goodrich Co., Akron, Ohio; Harrington Emerson, industrial engineer, New York; Charles Piez, president

The Link Belt Co., Chicago; Irving A. Berndt, manager betterment department, Joseph T. Ryerson & Son, Chicago; G. DeA. Babcock, production manager The H. H. Franklin Manufacturing Co., Syracuse, N. Y.; Willard E. Hotchkiss, dean Northwestern University School of Commerce, Chicago; Harry Franklin Porter, Detroit Executives' Club, Detroit, Mich.; H. Thorpe Kessler, President Western Efficiency Society, Chicago; Dexter Kimball, Cornell University, Ithaca, N. Y.; Morris L. Cooke, industrial engineer, Philadelphia; C. Day, industrial engineer, Philadelphia; Herman Schneider, school of engineering, University of Cincinnati, Ohio.

Temporary committees are now at work. Upon completion of the organization its services will at once be tendered to the government, through Howard E. Coffin, chairman of the advisory committee, Council of National Defense, and such other committees as can utilize the services of The Society of Industrial Engineers.

The temporary executive committee consists of Irving A. Berndt, chairman; F. M. Simons, Jr.; H. Thorpe Kessler; H. A. Rose; G. C. Dent, Harry Franklin Porter, C. A. Knoeppel, Willard E. Hotchkiss, S. T. A. Loftis and Charles Buxton Going. G. C. Dent is temporary secretary and H. Thorpe Kessler, treasurer.

The plan of organization adopted provides for a service or promotion bureau under the direction of a vice-president, and divided into two sections: (1) Advisory, and (2) Performing.

This is separate and distinct from the organization of the society proper, although under the direction of the president. The function of this bureau is to list as soon as possible all the industrial specialists in the country who may be qualified to serve either as advisers or as actual directors of efficiency work. From these two groups of advisers and performers the society will draw those necessary to carry on whatever work may be delegated to it in connection with perfecting preparation for war.

All men who possess qualifications that would enable them to serve in either or both of these sections are urged to get in touch with the acting secretary of the organization, G. C. Dent, 327 South La Salle Street, Chicago, as soon as possible.

I. A. BERNDT,
Chairman, Executive Committee.

SUBCOMMITTEES OF THE COUNCIL OF NATIONAL DEFENSE

As has already been noted in SCIENCE seven committees of the Council of National Defense have been organized. Their committees and their chairmen are:

Transportation, including railroad and motor transportation and communication, Daniel Willard, chairman.

Munitions, manufacturing, including standardization and industrial relations, Howard E. Coffin, chairman.

Raw Materials, minerals and metals, Bernard M. Baruch, chairman.

Labor, including conservation of health and welfare of workers, Samuel Gompers, chairman.

Supplies, clothing, etc., Julius Rosenwald, chairman.

Science and Research, including engineering and education, Hollis Godfrey, chairman; Henry E. Crampton, vice-chairman.

Medicine, including general sanitation, Franklin H. Martin, chairman.

Under *Raw Materials,* subcommittees have been formed with chairmen as follows:

General chemicals, William H. Nichols; *fertilizer,* Horace Bowker; *alkalis,* J. D. Pennock; *acids,* E. H. Grasselli; *miscellaneous chemicals,* Edward Mallinckrodt, Jr.; *cement,* John E. Morrow; *alcohol,* Horatio S. Reubens; *aluminium,* Arthur V. Davis; *asbestos,* Thomas F. Manville; *brass,* Charles F. Brooker; *coal tar products,* Wm. H. Childs; *lumber,* R. H. Downman; *lead,* Clinton H. Crane; *mica,* L. W. Kingsley; *nickel,* Ambrose Monell; *oil,* A. C. Bedford; *rubber,* H. S. Hotchkiss; *steel,* Elbert H. Gary; *sulphur,* Henry Whiton; *wool,* Jacob F. Brown; *zinc,* Edgar Palmer; *copper,* John D. Ryan.

The general chemical committee has established headquarters at Washington in charge

of Dr. Wm. H. Nichols, who is devoting all of his time to this work. The committee is cooperating with the Bureau of Mines, the U. S. Geological Survey and the Bureau of Soils in various problems, and all chemical problems are first submitted to this committee. The Manufacturing Chemists' Association of the United States and the National Fertilizer Association have also established offices in Washington in the Woodward Building.

THE AMERICAN PHYSIOLOGICAL SOCIETY AND THE WAR

The following letter has been addressed to members of the American Physiological Society:

The war has thrown upon the members of the national scientific societies unusual responsibilities. The growing conviction among those best fitted to know, that its further continuance will not be brief and that our country must act with her whole energy, makes it clear that every man of science must do his share. Some of the members of the American Physiological Society have entered military service and others are serving the country in a variety of other ways. As the example of England has shown, research is a field in which much can be accomplished, both of immediate relation to the needs of the moment and of permanent value. Under the direction of the committee on physiology of the National Research Council and the Council of National Defense comprehensive investigations of shock, industrial fatigue, food and nutrition, poisonous gases and means of protection from them, and other topics, are already under way. Other subjects demanding investigation will doubtless arise from time to time. The council of the American Physiological Society finds it desirable to know what its members are already doing or are willing to do in the way of national service, whether their laboratories will be open during the coming summer, whether they desire to undertake research in case of need, and, if so, what general lines of research they are prepared to follow. By the authority of the council, therefore, I write to make these inquiries of you. Any suggestions which you may feel like offering in regard to specific lines of research will be welcomed. Please make all records on the enclosed cards and return both to me without delay. The information so obtained will be turned over to the Committee on Physiology of the National Research Council, to be used as seems best. The members of this committee are:

W. H. Howell, *Chairman;*	Frederic S. Lee,
C. L. Alsberg,	Graham Lusk,
W. B. Cannon,	E. G. Martin,
A. J. Carlson,	Walter J. Meek,
Joseph Erlanger,	L. B. Mendel
Theodore Hough,	

In case your services can be utilized you will be duly communicated with.

(Signed) Frederic S. Lee

The registration cards accompanying the letter provided for the following entries:

What national service are you now doing?
Is it likely to continue during the summer?
Will your laboratory be available for research during the summer?
Are you prepared to undertake research for national service and, if so, in what general lines?
Suggestions regarding desirable lines of research.

SCIENTIFIC NOTES AND NEWS

An Anglo-French Scientific Commission which includes Professor Ernest Rutherford, of the University of Manchester, and Professor Henri Abraham, of the University of Paris, is at present in this country to cooperate with American men of science in the development and use of radio-telegraphy.

Secretary of the Navy Daniels has named Dr. William H. Welch, Dr. Flexner and Mr. Nathan Straus, of New York, as a committee to investigate Senator Calder's "round robin charge" that invalided sailors on the hospital ship *Solace* had been subjected to cruelty and neglect.

Dr. E. W. Morley was awarded the Willard Gibbs medal at a recent meeting of the Chicago Section of the American Chemical Society on May 18.

Dr. Richard M. Pearce, professor of research medicine in the University of Pennsylvania, has returned from a tour of three months through Brazil, Argentine and Uraguay to make a study of the medical, hospital, educational and public health conditions in those countries in the interest of the International Health Board of the Rockefeller Foundation.

DR. ALLAN J. MCLAUGHLIN, of Boston, has been appointed to succeed Dr. Richard P. Strong, of Boston, as chairman to the subcommittee on hygiene, medicine and sanitation of the Massachusetts Committee for Public Safety.

DR. MARCUS B. HEYMAN, formerly assistant superintendent of the State Hospital for Insane at Central Islip, L. I., and more recently medical inspector for the State Hospital Commission, has been appointed superintendent of the Manhattan State Hospital at Ward's Island, succeeding the late Dr. William Mabon.

DR. GEORGE DOCK, professor of medicine in the medical school of Washington University (St. Louis), has received the French war cross and has been mentioned for his service in moving wounded soldiers under heavy bombardment while engaged in the American Field Ambulance Service.

WE learn from *The Electrical World* that L. D. Gibbs, chairman, and Frank A. Birch, compose a committee of the National Electric Light Association to secure subscriptions to a fund of $5,000, in recognition of the work of Professor Elihu Thomson. A medal is to be awarded " in any year to any citizen of the United States or Canada who at the time of the award shall not be over thirty-five years of age, and who, in the judgment of the trustees of the medal, shall have made a notable contribution to electrical science or its industrial applications through original investigation, research or discovery, or through whose direct efforts a substantial contribution to the advancement of the industry shall have been accomplished."

FREDERICK BEDELL, professor of applied electricity, of Cornell University, has been elected one of the vice-presidents of the American Institute of Electrical Engineers.

A. W. L. BRAY, assistant professor of biology at the State University of Montana, has been granted leave of absence for one year, to take effect next semester. Professor Bray will engage in biological research work at Harvard University.

PROFESSOR A. B. RECKNAGEL, of the department of forestry of Cornell University, has received a leave of absence from his university duties in order to become forester of the Empire State Forest Products Association. He will take up his new work on July 1 and will establish headquarters for the association at Albany.

PROFESSOR L. B. GILLET, of the department of English literature at Wesleyan University, has resigned his position to enter military service.

PROFESSOR VICTOR GRÉGOIRE (Louvain), and Professor Hans Schinz (Zürich), have been elected foreign members of the Linnean Society.

WE learn from *Nature* that the government Central Control Board of Great Britain has appointed an advisory committee, consisting of Lord D'Abernon (chairman), Sir G. Newman, Dr. A. R. Cushny, Dr. H. H. Dale, Dr. M. Greenwood, Jr., Dr. W. McDougall, Dr. F. W. Mott, Dr. C. S. Sherrington and Dr. W. C. Sullivan, to consider the conditions affecting the physiological action of alcohol, particularly the effects on health and industrial efficiency produced by the consumption of beverages of various alcoholic strengths, with special reference to the recent orders of the Central Control Board, and further to plan out and direct such investigations as may appear desirable with the view of obtaining more exact data on this and cognate questions.

THE National Geographic Society has set aside $12,000 to finance another expedition to Alaska in order to obtain full information in regard to the eruption of Mt. Katmai. The expedition will be in charge of Professor Robert F. Griggs, of the department of botany, The Ohio State University.

MR. JAMES F. COUCH was elected president of the recently organized Des Moines Chemical Society at the regular meeting on April 9.

DEAN W. J. TEETERS, of the University of Iowa, has offered the facilities of the college of pharmacy there for manufacture of drugs and chemicals to be used in the war. He believes that students and faculty can perform

valuable service by making pharmaceutical preparations, pharmaceutical chemicals from raw materials furnished by the government, and in testing the identity and purity of drugs, chemicals and other medical supplies bought by the government in the middle west.

China has instituted a geological survey under the direction of V. K. King, a graduate of the University of Glasgow.

Wm. Mason Towle, professor of industrial engineering at Clarkson College of Technology, Potsdam, N. Y., retires from active service at the close of the present academic year. The trustees have appointed him professor emeritus of industrial engineering.

Mr. Francis C. Shenehon, for the past eight years dean of the College of Engineering of the University of Minnesota and head professor of civil engineering, has opened offices and will give his entire attention to his practise as a consulting hydraulic engineer.

Professor C. K. Leith, of the University of Wisconsin, has recently completed a six weeks' course of lectures on "Metamorphic geology" at the University of Chicago.

Dr. Juan D. Ambrosetti, director of the Ethnographic Museum at Buenos Aires, died on May 28. He was a delegate to the Pan-American Scientific Congress held in Washington in 1915.

Dr. F. F. Ulrik, of Copenhagen, who took the leading part in the movement to provide more hygienic homes for the laboring classes in Denmark, has died at the age of ninety-nine years.

Arrangements have been made for meetings of the Council of the British Association for the Advancement of Science, the General Committee and the Committee of Recommendations to be held in London on July 6, in order to make appointments, receive the report of the Council for the year, and transact other necessary business.

The Spanish government has appropriated the sum of $600,000 for the establishment of a hospital for infectious diseases at Madrid.

At the annual general meeting of the Institution of Civil Engineers of Great Britain, held on April 17, the result of the ballot for the election of officers was declared as follows: *President,* Mr. W. B. Worthington; *Vice-presidents,* Mr. J. A. F. Aspinall, Mr. H. E. Jones, Sir John P. Griffith and Mr. J. A. Brodie; *Other Members of Council,* Dr. C. C. Carpenter, Dr. Dugald Clerk, Colonel R. E. B. Crompton, Mr. M. Deacon, Sir Archibald Denny, Bart., Mr. W. H. Ellis, Sir R. R. Gales, Mr. A. J. Goldsmith, Sir R. A. Hadfield, Brigadier-General B. H. Henderson, Mr. R. W. Holmes, Professor Bertram Hopkinson, Mr. G. W. Humphreys, Mr. Summers Hunter, Dr. W. H. Maw, Mr. C. L. Morgan, Mr. Basil Mott, Sir H. J. Oram, Mr. F. Palmer, Captain H. P. R. Sankey, Sir J. F. C. Snell, Mr. E. F. C. Trench, Mr. W. F. Tye, Sir Philip Watts, Mr. E. J. Way and Sir A. F. Yarrow, Bart. The council has made the following awards for papers read and discussed during the session 1916–17: Telford gold medals to Messrs. G. W. Humphreys and J. B. Ball; George Stephenson gold medals to Messrs. P. V. O'Brien and John Parr; Telford premiums to Messrs. P. V. O'Brien, J. L. Hodgson, W. Brown and P. M. Crosthwaite, and a Crampton prize to Mr. F. J. Waring.

UNIVERSITY AND EDUCATIONAL NEWS

Announcement is made that next year a course in the elements of law, will be given by a professor of the law school of Columbia University to a limited number of qualified students of Barnard College. Certain courses in international law will also be open to specially qualified women.

Beginning with next autumn the Tufts medical school will require two years of regular college work for admission.

We learn from the *American Medical Journal* that fellowships in ophthalmology and otolaryngology in connection with the University of Minnesota have been established by Dr. Frank C. Todd, of Minneapolis, and Dr. Frank E. Burch, of St. Paul, both of the school of medicine. These fellowships carry with them the same stipend that is paid by the University of Minnesota to the university fellows, namely,

$500 the first year, $750 the second year, and $1,000 the third year. Such fellows will spend half their time in the private clinic of Dr. Todd or Dr. Burch, and the other half in laboratory and clinical work and in pursuit of certain courses for specialists in ophthalmology and otolaryngology at the university. For work done in these private clinics, credit will be given toward the degree granted by the university in the course of ophthalmology and otolaryngology given at the University of Minnesota, to accepted doctors of medicine covering a period of three years which prepares the physician for the specialty of ophthalmology and otolaryngology.

THE department of architecture of the University of Illinois is planning to take a leading part in rebuilding storm-stricken Mattoon. Sixteen architects of this department are to draw up sixteen standard plans for houses, the cost of which will range from $800 to $1,400. This work is being done in line with the school for city planning now being arranged for the coming summer. Officers of the university have expressed the hope that the institution may have an opportunity to duplicate on a larger scale in France what is now being done in the city of Mattoon.

PROFESSOR G. H. CLEVENGER, of Stanford University, has been appointed research professor in metallurgy and has been released from elementary and routine teaching.

PROFESSOR JOHN R. ALLEN, head of the department of mechanical engineering of the University of Michigan, has been offered the deanship of the college of engineering and architecture of the University of Minnesota.

MISS PAULINE H. DEDERER, instructor in zoology at Barnard College, has resigned to become assistant professor in biology at the Connecticut College for Women, New London.

DR. P. G. H. BOSWELL, lecturer in geology at the Imperial College of Science and Technology, London, has been appointed the first holder of the George Herdman chair of geology in the University of Liverpool. The establishment of a chair of geology in the university has been long delayed, and is now possible owing to the generosity of Professor and Mrs. Herdman, who have endowed the chair as a memorial to their son, the late Lieutenant George Herdman.

DISCUSSION AND CORRESPONDENCE

THE PHYSIOGRAPHY OF THE LOWER AMAZON VALLEY AS EVIDENCE BEARING ON THE CORAL REEF PROBLEM

THE recent revival of the discussion of the origin of coral reefs[1] has raised many questions which involve not only the coral islands, but also the displacements of the strand lines of the continents throughout the tropics, for the changes in level of the tropical seas invoked by Daly must have been recorded on the continents as well as on the islands. It seems, therefore, that a thorough investigation of at least a considerable number of critically situated continental strands of the tropics must be made before the evidence for or against the acceptance of the glacial control theory may be considered complete.

Recently, in his reading, the writer found an account of the physiography of the lower Amazon valley[2] to which it seems worth while to call attention for the benefit of any who may undertake an investigation of the evidences of strand-line displacements in the tropics.

A brief abstract of a portion of Smith's paper follows: All of the larger rivers entering the lower Amazon from the south, and the Trombetas entering from the north, have lake-like expanses in their lower courses into which the Amazon, at times of flood, is pouring silt which is gradually filling them up. Meanwhile the upper ends of the estuaries are being filled by their own rivers. Some of the latter, which are muddier than others, have already trans-

[1] Daly, R. A., "The Glacial Control Theory of Coral Reefs," *Proc. Am. Acad. of Arts and Sciences*, Vol. 51, 1915, 157–251. Davis, W. M., "A Shaler Memorial Study of Coral Reefs," *Am. Jour. Sci.*, 4th ser., Vol. 40, 1915, 223–271. Vaughan, T. Wayland, "The Platforms of Barrier Coral Reefs" (abs.), *Am. Geog. Soc. Bull.*, Vol. 46, 1914, pp. 426–429.

[2] Smith, H., "Physical Geography of the Amazon Valley," *Am. Nat.*, Vol. XIX., 1885, 27–37.

formed their former estuaries into alluvial plains above which rise scattered rocky islands. This is particularly true of the northern tributaries of the lower Amazon, except the Trombetas, which has relatively clear water, and has not yet filled its estuary.

The author suggests that the physiographic features described above may be interpreted as the result of a moderate drowning of the region followed by the filling up of the estuary of the Amazon by the heavy silt burden borne by that river:

> Gradually the alluvial land at the head of the bay extended eastward, filling up the estuary with islands. As this eastward movement went on, the branch estuaries were blocked up at their mouths by islands which formed in front of them. Where the branch received a muddy tributary it also filled up; but the clear water tributaries like the Tapajós, Xingú, and Trombetas, brought down no sediment, and their estuaries, closed at the mouths, assumed the form of lakes.

That the phenomena described are the result of changes in level and not merely of the ponding of the tributaries by sediment from the Amazon, is indicated, as the author points out, by the fact that the Tocantins River, which enters the sea directly, has a similar estuary.

The physiographic phenomena here described seem to point to a relatively recent period of lowered sea level (or land uplift) followed by a rise to the present position (or a sinking of the land). The phenomena may have been associated with the changes in sea level postulated by Daly, or they may be due to local crustal movements. Physiographic studies of a large number of tropical rivers would go far toward solving the problem.

John L. Rich
University of Illinois

QUOTATIONS

A PIONEER IN PHYSICS

Forty-seven years of collegiate teaching constitute in themselves a sufficient title to honor, even though their number be only a record of faithful and continuous service. When the passing of these years has told also a story of important pioneer work, of purposeful achievement and steady progress, it becomes a record to conjure with. Of such is the repute that Professor Charles R. Cross has established in the long period of his association with the Massachusetts Institute of Technology, and of such the honor which the institute and all men are glad to accord him as he now lays hold upon the satisfactions of a well-earned retirement. Being graduated from Massachusetts Institute of Technology in 1870, with the third class that went out from its halls, Professor Cross forthwith returned after the summer vacation to take up an instructorship in the department of physics. Upon completing a single year of this service he was made an assistant professor and by 1878 had been given rank as a full professor. In 1886 he became director of the Rogers laboratory and in 1907 was made head of department. It is the threefold mantle of these responsibilities which he wears to-day and which he now contemplates laying aside.

Such accumulated funds of loyalty to his institution, of prestige not only in its counsels but in the scientific world at large, and such skill of investigation and analysis as Professor Cross has acquired, constitute a tangible fortune which might well be assessed only for its large present values. Yet if one is to take his career in review, there must be observed in particular the contribution Professor Cross made to the establishment of electrical engineering as an independent department of modern scientific and technical training. In the early eighties, some time before the wondrous expansion in the practical uses of electricity had generally been foreseen, Professor Cross prophesied it and insisted on electrical studies as part of his teaching in physics. He offered them long before they were taken up by other educators throughout the country, he developed their technique and bore the brunt of a pioneer's labor. Later it was at his instance that Technology introduced the first courses leading to a degree in electrical engineering ever offered in America. All through this development, his influence made for the increasing use and effectiveness of experiments in the illus-

ration of lectures—that most important hange of emphasis which came to pass in the iethod of scientific education. Professor ross has won high place, which he will hold, hether or not in retirement.—*Boston Evening Transcript.*

SCIENTIFIC BOOKS

The Birds of Britain, their Distribution and Habits. By A. H. EVANS, M.A., F.Z.S., M.B.O.U., Cambridge, 1916. 8vo, pp. xii + 275, numerous halftone text-figures.

This concise and rather informal work is stated to be "primarily intended for schools," but is designed also to serve as a "short handbook which includes the results of the most recent observations, and is adapted to modern nomenclature." While this intention may be justified by the character of the main text, the introductory chapter, treating of "The Class Aves, or Birds in General," might have been written a generation ago, and does not include "the results of the most recent observations," as regards especially the subject of migration. Reference is made only to the creditable work of local observers in Britain, which has accumulated interesting facts regarding the movements of birds in England and Wales without furnishing generalized results, while the important work carried on elsewhere is passed without mention, including the researches of the late W. W. Cooke which have so greatly extended our knowledge of this subject.

In the main text, under the general heading "Classification," with subheadings for the higher groups from orders to subfamilies, a paragraph, without special heading, is devoted usually to each species of regular occurrence in Britain, with a nominal list at the end of nearly 200 "occasional visitors" not formally mentioned in the preceding pages. The author manages to give in the half-page notices of the species of regular occurrence a comprehensive statement of their leading traits, distribution and diagnostic features, in a clear and direct way that should render his "little book" attractive and useful to many readers. The nomenclature is strictly modern, being "almost exactly" that of the British Ornithologist's Union's revised Check-list. The illustrations, though said to be "from photographs taken for the most part from nature," are in many cases obviously not from life but from stuffed specimens or from museum groups, and are thus not up to the standard of the text.

J. A. A.

SPECIAL ARTICLES

FACTORS IN THE GROWTH AND STERILITY OF THE MAMMALIAN OVARY

1. THE growth and, to some extent, the structure of the mammalian ovary depend essentially on the development of the ovarian follicles. The maturation of some follicles and the subsequent rupture leads to the formation of the corpus luteum; the retrogression (atresia) of follicles before they have reached maturity and ruptured leads in certain species to the formation of the so-called interstitial gland and in others to the accumulation of atretic follicles in which the theca interna is relatively prominent, without, however, the formation of an interstitial gland.

As we shall see presently, it is possible to inhibit the full development of the follicles experimentally. Under these conditions we find that the atretic follicles with relatively large thecæ internæ, are especially numerous and constitute, perhaps the greater part of the ovary. We may therefore conclude that it is the pressure exerted by the developing, expanding follicles which leads to the shrinking and ultimate complete disappearance of the atretic follicles, and that if this pressure is diminished these atretic follicles become relatively prominent. This explains their relative preponderance in the guinea pig during the period following ovulation, when no large follicles are present in the ovaries.

2. Former observations of the writer showed that under certain conditions mitoses in the granulosa cells of the follicles were especially frequent around the ovum. This suggested the possibility that the stimulus for the growth of the granulosa cells which ultimately determines the growth of the whole follicles, depends upon a substance given off by the ovum. Dr. L. S. N. Walsh in our laboratory

has recently shown quantitatively that during the whole course of the development of the follicles definite relations exist between the ovum and the proliferation of the granulosa cells. These relations can hardly be explained in any other way than as dependent upon a growth stimulus emanating from the ovum and determining the proliferation of the granulosa cells and thus indirectly of the whole follicle. It is possible that in addition to this endogenous growth stimulus certain exogenous stimuli, emanating from other organs with internal secretions (hypophysis?) may be operative. This effect of the ovum on the granulosa cells leads to the formation of the cumulus oophorus, and this structure makes possible the escape of the ovum into the Fallopian tube. Thus the ovum is ultimately the seat of the mechanism which makes possible its fertilization and fixation in the uterine wall.

3. In previous investigations[1] we have shown that it is possible to cause a premature atresia of follicles by the burning out of the corpora lutea. While the effect of moderate heat does not directly destroy the follicles, it diminishes their expansive power; they grow up to a certain point and then become prematurely atretic; the heat causes a mild degree of what might be called a "tissue shock." Under those conditions the development not only of mature, but even of moderately sized follicles, does not take place and as long as this condition lasts the animal is sterile.

4. In continuation of these experiments we found that it is possible to produce the same condition not only by means of a local interference with the ovary, but also by affecting the general state of nutrition through underfeeding the animal. In all cases in which the animals (guinea pigs were used in our experiments) had lost 25 per cent. of their initial weight maturation of the follicles ceased, and in the majority of the cases the follicles became atretic before they had reached even medium size. The changes in the ovary were on the whole more pronounced in younger animals weighing between 300 and 400 grams, but in some cases very marked changes were also produced in older animals. A certain minimum time has to elapse before the changes in the ovary become apparent.

The lack of sufficient food affects in the first place the granulosa cells; they prematurely dissolve. Those granulosa cells, however, which at first escape the solution, continue, as Dr. Walsh found, to divide at approximately the normal rate—another proof of the distinctness of proliferative stimuli and foodstuffs.

The connective tissue becomes affected by the underfeeding somewhat later than the granulosa. This apparent difference in the resistance of different tissues to the effects of underfeeding is of interest and will be tested in further experiments. Thus underfeeding, if very marked, will lead to at least temporary sterility in the guinea pig as an expression of what we designated as a "hypotypical" condition of the ovaries.

5. In one case of pronounced loss of weight following thyroidectomy, we found a still further reaching change. Not only were the ovaries hypotypical, but the stroma separating the various follicles had become affected. It was underdeveloped or lacking in places, so that the thecæ internæ of neighboring follicles in places directly adjoined each other. As a result of this condition and of an imperfect separation of primordial ova, due to the same relative inactivity of the connective tissue, many follicles containing two or more ova developed in both ovaries. It could be clearly seen that small follicles were pushed into the cavity of neighboring follicles as a result of the intraovarian pressure, which, while diminished in hypotypical as compared with normal follicles, was still positive and as a result of the lack of development of ovarian stroma. Follicles containing more than one ovum are occasionally found in the ovaries of various species and it would be of interest to determine whether in addition to the factors operative in our case, other factors may be responsible for this condition in other cases.

Leo Loeb
Department of Comparative Pathology,
Washington University

[1] Loeb, Leo, *Zentralblatt f. Physiologie*, 1911, XXV., No. 9. *Virchows Archiv*, 1911, CCVI., 218.

SEGMENTATION IN NEMATODES:

OBSERVATIONS BEARING ON THE UNSETTLED QUESTION OF THE RELATIONSHIP OF NEMATODES TO OTHER BRANCHES OF THE ANIMAL KINGDOM

I HAVE long been impressed by certain evidences of segmentation in nematodes. My first impressions arose from a study of the distribution of the setæ on aquatic forms. This distribution was in those days, and is even yet, described as irregular; the setæ are said to be "scattered" on the body. Charting all the setæ on a given specimen led to the conclusion that they were, not scattered ("zerstreut"); that, rather on the contrary, they constituted a series of more or less harmonious groups. The cephalic setæ, it is well known, have an orderly arrangement. The study of a large number of cases leads me to the conclusion that those setæ, some distance behind the cephalic setæ, denominated subcephalic setæ, are also orderly in arrangement, and might, in some instances at least, be regarded as repetitive of the cephalic setæ.

Later I was able to show that the transverse striæ of the cuticle are retrorse on the posterior half of the body, and the reverse on the front half. (See Fig. 1.) This reversal in the cuticle at the middle of the body, or thereabouts, occurs in a very wide range of genera, is independent of age and of sex, and seems a character of fundamental significance.

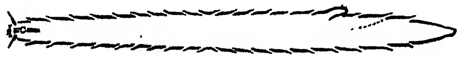

FIG. 1. DIAGRAM OF THE REVERSAL OF THE STRIÆ OF THE CUTICLE OF A NEMATODE.

Recently I have discovered that the principal cephalic organs are made up of segments which, while simple in character, bear no small resemblance to corresponding features in arthropods. The nature of these segmented appendages will be more easily understood by consulting the illustrations in Fig. 2.

The articulations in the cephalic organs of nemas are not easy to discover, owing to the small size of the organs and the transparency of the tissues. Some of these segmented organs are under muscular control, and can be extended and inflexed after the manner of the palps of insects. This is true of some of the labial organs, which unfortunately are usually so small as to be difficult to observe. The cephalic setæ, however, are larger, being particularly well developed on some marine forms, and in this case observation on living specimens affords evidence of the articulations when they might be overlooked if they were sought by other methods; for if a seta is obstructed it takes on the attitude natural to an organ composed of flexible joints and more or less inflexible segments, as shown in the upper illustration, Fig. 2. Here again, once having established the fact and learned how to make the observations, it proves that the setæ of a wide range of genera are jointed, though the number of segments is often reduced to only one or two.

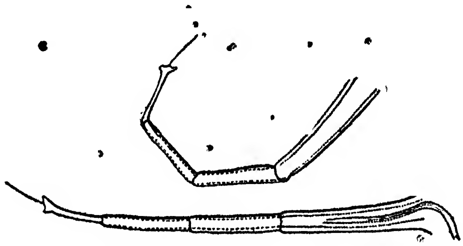

FIG. 2. CEPHALIC SETA OF A NEMATODE, SHOWING SEGMENTATION. TWO DIFFERENT ATTITUDES OF THE SAME SETA.

One recalls that a number of observers have noted the presence of longitudinal series of repetitive organs in the lateral fields of nematodes, though attention has never been called to the fact that these organs on opposite sides of the body may be symmetrical to each other. Sometimes they are exactly so.

N. A. COBB

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE 119th regular meeting of the Botanical Society of Washington was held at the New Ebbitt Hotel, on March 14, 1917. Seventy-four members and sixty-five guests were present. After a dinner President T. H. Kearney introduced the re-

tiring president, A. S. Hitchcock, who addressed the society on "Taxonomic Botany and the Washington Botanist."

The speaker stated that the members of the Botanical Society of Washington are nearly all specialists in the employ of the national government. They must depend upon extra-official opportunities for broadening their outlook and for keeping in touch with the development of botanical research. The speaker brought to their attention the opportunity afforded by a study of the local flora. Every scientist should have training in the two methods for establishing facts, that of experiment and that of repeated observations. The first method is used by the physiologist; the second by the taxonomist. In studying the local flora the Washington botanist can train himself in taxonomic methods and at the same time accumulate valuable botanical data. The speaker outlined the fundamental scope of taxonomic training and called attention to the ways in which the student should apply the general principles to his studies of the local flora. The investigator should free himself from the shackles of authority. He should see things as they are rather than as others say they are. He should learn to make accurate observations and to use these to determine the truth and not to establish a theory or a concept. In all his investigations he should keep his criterion of accomplishment well in advance. He whose ideal is his own best work ceases to progress. Finally the speaker advised young authors, when publishing, to prepare their manuscript with care in regard to clearness, conciseness and technique. Clear thinking leads to clear writing. Care in technique may be taken as an evidence of care in gathering the data which the writing records.

The address will be published in full in the *Journal* of the Washington Academy.

H. L. SHANTZ,
Corresponding Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 566th meeting of the society was held in the assembly hall of the Cosmos Club Saturday, February 24, 1917, called to order by President Hay at 8 P.M., with 50 persons in attendance.

Under the heading book notices, brief notes, exhibition of specimens, etc., M. W. Lyon, Jr., called attention to the latest edition of the International Rules of Zoological Nomenclature containing a summary of the opinions that have been rendered by the International Commission, compiled by Mr. John Smallwood, of Washington.

Dr. R. W. Shufeldt communicated a short paper entitled "Notes on the Trunk-fishes" and exhibited a specimen of *Lactophrys tricornis*.

Dr. L. O. Howard commented on the parent tree of an unusually fine variety of oranges and the extraordinary care taken of it by the owner during the recent cold weather in Florida.

Mr. Wm. Palmer also commented on the effects of the recent "freeze" in Florida.

The regular program consisted of three communications as follows:

T. S. Palmer: "A Pioneer Naturalist in Southern Florida—Extracts from the Diary of Titian R. Peale, 1825."

Dr. Palmer gave a detailed account of Peale's collecting trip in Florida in 1825 made for the purpose of securing birds for Prince Louis Bonaparte and mentioned and exhibited the species of birds discovered by Peale as new to science or new to the United States. He read extracts from Peale's diary and called attention to the other scientific expeditions of which Peale was a member giving many interesting facts of his long life.

Some Notes on the Aleyrodidæ: A. L. QUAINTANCE.

The Shad and its Relatives in the Mississippi River: EMERSON STRINGHAM (introduced by R. E. Coker).

Mr. Stringham said that herring-like fishes found in the Mississippi River possess more economic significance than formerly recognized. The two mooneyes (*Hiodon*) have flesh of excellent quality, but they are not sufficiently abundant to be of great importance; they eat principally insects, and feed both summer and winter, day and night; they deposit their eggs as soon as the water temperature begins to rise in spring. The gizzard shad (*Dorosoma*) which serves as food for other fishes is less abundant in the Mississippi proper than in slues and lakes. The river herring (*Pomolobus chrysochloris*), known as the host of a mussel of great value, feeds on insects when they are abundant, and on fishes at other times; it breeds early in summer; fears are entertained that the fish and mussel may be excluded from the upper river by a dam at Keokuk, Iowa. The Ohio shad (*Alosa ohiensis*) seems clearly distinct from the Atlantic shad, but is sufficiently similar to be equally good food, though smaller; on the Mississippi this valuable resource is not utilized; the habits of the fish are similar to those of the Atlantic species, but it has not yet been proved to be anadromous.

M. W. LYON, JR.,
Recording Secretary

SCIENCE

FRIDAY, JUNE 15, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE RELATION OF WAR TO CHEMISTRY IN AMERICA[1]

WAR is an evil beyond the power of language to express. To kill one's neighbor or one's enemy is so repellent a thought that one cries out in horror at the idea and instinctively wants to refuse to have any part in action or government which involves such baseness irrespective of the provocation. It is only with the greatest difficulty that we persuade ourselves to act together in any such capacity except in spontaneous defense. Were it not for the religious emphasis upon our duty to support the civil magistrate in the execution of righteous law, and therefore to resist aggression against such law, we would find little ground to stand upon in our present crisis, except it be the desire to bring annihilation upon the philosophy which gave rise to this world war.

It has become more and more apparent that we have been dealing with a power in the case of Germany that is as unscrupulous as her acts are unmanly and cruel, and that the complaints of her opponents against her since 1870 have probably not been overdrawn. The pall of horror and indignation which fell upon us during the invasion of Belgium and France was relieved when the Marne gave hope that there was still power enough in the world to frustrate the dream of the bully. This pall has been slowly growing upon us again, however, in spite of the persistent efforts of the German propaganda amongst us to conceal and belie the reports of the damnable conduct of their armies and government at

[1] The annual address before the Ohio Academy of Science, Columbus meeting, April 6, 1917.

home and in the hapless countries for a time at their mercy. Because of these things we see men everywhere bowed down and depressed as it becomes clearly demonstrated that science, mental endowments and education are no specifics against a wicked heart. These things we really knew before but refused to believe. They are demonstrated to us now by appalling examples so that the whole thinking community has become so mentally and spiritually depressed that one has great difficulty in going about one's normal work, health is damaged and continued research is a matter of great difficulty. A nation of unusual opportunities, great mental endowment and development in science seems to have become the willing or at least easily manipulated pawn in the hands of the unscrupulous statesman. We have not forgotten that it was a chemist, Ostwald, in the early days of the war, when he was acting as a spokesman for Germany to men of science throughout the world who was quoted, when Germany was in the flush of her initial victories over Belgium, as saying the world had outgrown the idea of freedom for little or weak peoples.

War, therefore, is a universal mental depressant and as such, alone, must damage progress in science. It saps national energy and material resources. It destroys the life of the younger generation of scientists and, in large part, the student material from which the scientists of the future are recruited. It interferes with systematic research in many lines by mentally depressing the workers, placing insuperable difficulties in their path and at times by destroying priceless work, records and literature. Certainly war is not desirable to science, even if we could restrain our detestation of it and all its works.

Bitterly as we may condemn war, we should be wrong, however, to claim that science stagnated or declined in war time. Since war requires brains, science is of course utilized, and since the demand is inexorable, science must produce, and when science and engineering are producing, they grow. We have come to learn that modern war is a scientific business undertaking. It involves the use of all vital human endeavors, and therefore to varying extent, of all applied science. On the one hand, it involves the utilization of medical science to maintain physical efficiency and speedily repair damage to the fighting machine. On the other hand, it involves the utilization of agricultural, physical and chemical science in feeding and clothing the whole military and naval establishment, and manufacturing the equipment, armament and "concentrated energy" or explosives consumed by the fighting force. It is stated that it requires three men in the shops to maintain one man in the army and seven men for one in the navy. It is evident therefore that it is the applied portions of science that are most used and hence that grow most under war's influence. It is common experience, however, that the stretching into new domains and the striving for new goals by applied science, enriches the feeding ground of unapplied science and uncovers fertile fields for the patient and quiet research which follows and which often becomes the very backbone of science itself. These results are scarcely visible and will not mature in any event, for years after the war, so that we can see at present little good effect upon unapplied science and we feel quite certain that the reverse influences have the upper hand.

Although it would not be wise at present even if we had the time to go into detail in discussing this subject nor would it profit you particularly, yet it may be useful to emphasize certain points of view which come sharply to our attention when we attempt to survey the field.

WAR'S DAMAGE TO UNAPPLIED CHEMISTRY

We could scarcely expect to estimate the retarding effect of the war on chemistry, because we can not pry into it deeply and broadly enough to prove our impressions, for research is partly in the minds of scientific workers. However, certain signs of influences actually exist which tend to weaken and retard progress. The American Chemical Society of some 9,000 members, the largest chemical society in the world, publishes twice a month the journal *Chemical Abstracts*. Its editorial offices are in the chemistry building, a few steps from the one in which we are now assembled. *Chemical Abstracts* has for some years covered the field of chemistry by abstracts more thoroughly than any foreign journal of the kind. It reviews some 600 journals from all parts of the world and there is spent upon it by the American Chemical Society an annual budget of over $40,000. It is easily seen that this must be the most powerful and most important agency for research in chemistry, and perhaps also in any science, that exists in the world. Some quantitative idea of the evil effect of the war upon chemistry in general may be gotten from its effects upon this colossal agency for assisting applied as well as unapplied research in chemistry.

Inquiry to the editor of *Chemical Abstracts* developed that the effect of the war on current chemical literature as reflected in *Chemical Abstracts* may be shown approximately by the following statement:

Total No. of abstracts published (patents included) in 1913	25,971
Total No. of abstracts published (patents included) in 1914	24,388
Total No. of abstracts published (patents included) in 1915	18,449
Total No. of abstracts published (patents included) in 1916	15,784

These figures are fairly representative of actual publication of original papers of more or less direct interest to chemists, as *Chemical Abstracts* has continued closely to approach completeness in spite of war conditions. The quality of the papers being published is somewhat below the normal standard. Not a great many foreign chemical journals have entirely ceased publication since the war started, but all show a more or less marked decrease in the number of pages turned out. Most of the French and German journals are published much less frequently than in normal times, two or more numbers being grouped under one cover. Apparently no important English, Italian or Russian chemical journal has ceased publication since the war started. The following list includes the journals concerning which we have uncertain information but which *indicates* that they have probably ceased publication due to the war:

English:
Chemical World.
One journal.

German:
Böhmische Bierb.
Deut. med. Wochschr.
Leipziger Färber-Ztg.
Silikat-Z.
Technikum.
Zentr. Exp. Med.
Z. exp. Med.
Z. Hyg.
Eight journals.

French:
Ann. Mines.
Arch. biol.
Arch. intern. pharmacodyn.
Arch. intern. physiol.
Arch. med. exp.
Betterave.
Brass. malt.
Bull. sci. pharmacol.
Bull. soc. franc. min.
Bull. soc. geol. France.
Bull. soc. ind. Amiens.
Bull. soc. ind. min.
Bull. soc. ind. Mulhouse.
LeCuir.
L'Engrais.

J. d'agr. trop.
J. des. fabr. sucre.
J. physique.
J. sci. math. phys. nat.
Radium.
Mon. ceram. verr.
Mon. teint.
Nord Brass.
Papier.
Petit brasseur.
Rev. chim. appl.
Rev. chim. ind.
Rev. electrochim.
Rev. viticulture.
Rev. gen. mat. color.
Sucrerie Ind. colon.
Thirty-one journals.

Austrian:
Oesterr. Z. Berg. Hüttenw.
One journal.

Belgian:
Bull. acad. roy. med. belg.
Bull. sci. acad. roy. belg.
Bull. soc. chim. belg.
J. pharm. soc. d'anvers.
Rev. intern. pharm.
Sucrerie Belg.
Chimiste.
Seven journals.

The *cost of publication* of *Chemical Abstracts* has been increased by about 10 per cent. as a result of the war. This is chiefly due to the increased cost of paper. The same percentage increase will enter into the cost of the Decennial Index to *Chemical Abstracts,* which is about to be issued by the American Chemical Society at a cost of over $30,000.

Need we go further for evidence of the ill effects of war upon science? Certainly it takes little insight to see that this stoppage or at least side-tracking of the wheels of chemical research will be felt in this science for years to come.

WAR'S RELATION TO APPLIED CHEMISTRY

In considering the applied side of chemistry let us remember that war is essentially engineering. Its object is to overcome natural and artificial obstacles. It must therefore get results which are deliberately selected at the will of those directing the war. It insists, therefore, that every one and everything must produce. Its *main* agents are engineering and applied chemistry, the engineering, because it struggles with the problems of space and time and material for tools and weapons, and applied chemistry, because it is a necessary handmaiden to efficient engineering, and in addition furnishes the source and vehicle for convenient and effective handling of energy in the most concentrated forms. The chemical energy of the modern high explosive is the strong right arm of the fighting force and without it armies are but chaff. With British control of the seas, German armies with all their numbers, thorough equipment and splendid military power, would have been impotent in a few weeks or months without the chemical ability to get nitric acid from atmospheric nitrogen instead of Chilean nitrate, for without nitric acid high explosives and even smokeless powder are impossible.

The time at our disposal is too brief to touch on all the divisions of applied chemistry. Much progress, for instance, has been made in the domain of the special branch called engineering chemistry which involves among other things, the chemical investigation of materials for alloys, shrapnel, aeroplanes, submarines and other war supplies. It would be unwise, now that we have become involved in the war, to deal publicly with some of the improvements in this field, for they are vital as well as interesting. Some of us have followed the policy during the last three years of not even discussing with our colleagues or students such innovations of military importance in this and the allied countries as have come to our attention, which might by any means percolate into Germany. The branch of applied chemistry known as metallurgy in which this country is perhaps the most

highly developed in the world also renders distinct service in war time because it is vital to engineering and in the production of arms and ammunition. We, however, will emphasize more particularly the twin fields of industrial chemistry and chemical engineering, because in the nature of things this field is less popularly known even among chemists. Industrial chemistry is that branch of chemistry which uses all the rest of chemistry and much engineering, for the furtherance of production of chemical substances, or, the use of chemical means or methods for manufacturing any material of commerce. Chemical engineering is that branch of engineering and industrial chemistry which applies engineering principles and methods to chemical manufacturing or production. Because their aim is production these two fields have been largely dominated by war conditions for the past three years. On them the war has had two mutually antagonistic effects, the one retarding or injuring and the other developing and benefiting.

WAR'S DAMAGE TO CHEMICAL INDUSTRY

The main factors vital to success in any chemical industry are

I. Thorough knowledge of an assured market.

II. Possession of at least one well studied and workable chemical process and chemical ability to handle it economically under varying raw material and finished product markets.

III. Possession of engineering ability to carry out and maintain in operation the chemistry involved in the process.

IV. Sufficient margin of profit to attract capital and business confidence in chemical and engineering ability in meeting the problems of the field.

Any thing or any one who weakens or strikes at any of these four factors is an enemy of chemical industry and does damage to it.

When war was declared in Europe stagnation set in at once in the chemical industries and indications of disaster were the rule in many of them. Petroleum refining, turpentine, rosin and wood products among others, were hard hit because we are strong exporters and such industries as mixed fertilizer manufacture also, because we import heavily of potash. This stagnation could not last long since the chemical industries underlie the whole fabric of modern industrial development and civilization, and production is necessary to life. Eventually, therefore, the chemical industries were forced to resume operations but great uncertainty as to markets rendered operations difficult and held back many changes in processes and equipment rendered necessary by changes in source or kind of raw materials. The nature of these industries is often such that the failure of supply of one chemical raw material even if used in but limited amounts may prove fatal by rendering the product unsatisfactory to the market if indeed it is not entirely valueless. A good illustration of the vital importance of accurate knowledge of the market in these chemical industries is furnished by the dye situation, where we had recently the anomalous condition of bitter complaint of shortage by consumers simultaneously with utter inability of some producers to market their product, and still other producers with large contracts for product and inability to produce due to poor deliveries or failure of equipment. These difficulties do much harm since they tend to discourage capital and it must not be forgotten that industrial chemical development is impossible without capital. German chemical manufacturers understood this clearly when they organized American branches of their color works, eliminating American employees to conceal

the market and its peculiarities, and placing all their business in the hands of "American citizens" of German name. Then when the U. S. Bureau of Foreign and Domestic Commerce attempted last September to publish the amounts of each dye consumed in this country they vigorously protested that their rights as American citizens were being infringed by encouraging competition. The uncovering of this octopus to public gaze should be set down to the war's credit. It has long been a familiar animal to many industrial chemists.

Another evil effect of war, a common one now greatly intensified, is the discouragement of capital by failure of hasty and ill-advised manufacturing projects. Successful speculators and others have been influenced by the potential earning capacity of industrial chemistry and have jumped into projects with little study and no experience. Often such capital has not known enough to employ chemical engineers, but has put growing works into the hands of electrical and mechanical engineers whose general engineering sense has not always saved them from physical disasters that chemical experience would have avoided. Such engineers and capital and, sad to say, many chemists, who either lacking entirely in manufacturing experience or having *had* manufacturing experience, though they acquired no sense of responsibility to protect capital against hazard from decisions without basis in experience, have been the easy victims of the machinery and equipment company who needs but to see a plant, or a picture in a book, and they will design you one while you wait. There not being the proper engineering check such plants fail at times with regretable loss of life, as well as capital and confidence in things chemical, or if they succeed (because the process is simple and well known) the plant can be counted upon to cost from 50 to 100 or more per cent. higher than it should.

The equipment companies and their engineers are not necessarily dishonest. They sell equipment, and who but they are responsible if they do not sell you enough equipment when you consult them for advice in designing our plant? They, therefore, sell you enough. Experienced engineers will often cut the estimates of such equipment manufacturers in half.

Another illustration of how this situation works out in practise might be given in the case of benzol refining. This is an important matter in modern high explosive manufacture. Some little time ago the best text ever written in English on industrial chemistry contained a chapter by a chemical engineer who had ample opportunity of observing the best American practise (which happens to be second to none in the world). His chapter on this subject, therefore, is a classic, but in illustrating the text he did not reproduce details of stills, for instance, with engineering exactness, but allowed the artist who made the drawings considerable leeway to his imagination. In fact, he left out entirely a vital feature in the construction of such stills. Were it not for the loss of efficiency and the expense involved, you would be greatly amused if you could go with me to a number of the refineries built in this country in the last two years under war pressure by machinery companies, for good engineers who were not themselves experienced in this industry but who needed the industry as one of the links in their larger operations. In every case the stills were built exactly patterned after the pictures in this text and in no case were they efficient or as nearly efficient as was possible, if a little thought regarding the use to which they would be put had been given them. They were built to sell, not to operate.

The same capital newly invested in

chemistry is also the easy victim of another evil which is necessarily costly to industrial chemistry and is a heavy blow to the whole science. This evil is the ignorant or unscrupulous chemist. The great difference between industrial chemical research and other chemical research is that the former *must* produce results on the question in hand while the latter may ramble if necessary into less difficult fields. When inexperienced capital is seeking chemical assistance, the first individual it meets who claims to be a chemist is assumed to be competent to handle any problem without inquiry into his past experience. This same capital would scarcely employ a bridge engineer to design a dynamo, yet plant after plant for chemical manufacture has been constructed in the last two years in this country with no more intelligence than this. As a result literally millions have been squandered and lost in these unsuccessful plants. But unfortunately, enough such plants are successful, that their authors escape the penalty of their dishonesty, and therefore, the evil persists and continues. Plants have been constructed for the manufacture of high explosives by engineers who knew nothing of the business, resulting in great loss of property and even life from their final destruction, or in abandonment where they proved unprofitable. I have heard of plants erected for the concentration of sulphuric acid in which a battery of stills for this purpose costing in the neighborhood of a quarter of a million dollars was placed in operation without even a single experiment preliminary to erection, on the type of material to be used, and not even a trial run on *one* of the stills before all were placed in operation. The first day they operated was the last day, for they all went into solution in the acid.

Men who were or claimed to be chemists have read how simply some reactions described in the general chemistries work, and designed a plant upon their nerve or—as they thought—common sense, and found to their consternation that under the conditions they made for themselves the reaction did not proceed at all, or they were so inexperienced in large-scale operations that they could not recognize what they had when the work was under way. Others have so far lost their heads by publicity or financial possibilities, even though good chemists, that they have assumed that what could be done with raw material from one source could be equally well done with it when from another source, provided they merely proved its actual presence in the new product. Ignoring the whole history of chemical as well as industrial chemical development that the chemical environment profoundly affects chemical reaction, no adequate confirmatory studies were made before capital to the extent of hundreds of thousands of dollars has been induced to invest in such guesses, with disastrous results to capital and grave loss of confidence in chemical research. These things are in large part due to or at least the losses could only be so heavy under war pressure. Processes which gave every promise of success have been hurried into failure or near failure by undue publicity giving premature capitalistic confidence in them and it is with profound regret that we see the passing for the time at least of such things as toluol from petroleum, which more attention to study may still make useful in war emergency at least.

These are outlines of some of the evil influences due to or accentuated by war. They are in part of such a technical or professional nature that they should not have been imposed upon your attention unless it were to protect you against misunderstanding the just criticism of the results of these evils and to emphasize that we do not consider war an unmitigated blessing if we

should appear enthusiastic about the progress that has been made in war time. Then too we should always ponder more over our lapses. The successes can take care of themselves.

PROGRESS IN APPLIED CHEMISTRY IN WAR TIME

There is indeed another side than the evil we have been discussing. There has been much real progress. The evils mentioned are largely growing pains. Engineering and its services to mankind have been long appreciated to some extent at least. Chemistry is less easily understood. The everywhere present applications of chemistry pass unnoticed for the most part in everyday life. Probably the greatest contribution to science, therefore, of the present war, is the awakening of the average mind to the power and value to mankind of that group of phenomena which we study as chemistry. This is probably because we most easily grasp and appreciate applications rather than generalizations, and the use of chemistry in war has been a revelation to the general public.

In other ways also this war has effected a development in chemistry and its applications which has outstripped any influence since the modern foundations of the science were laid over a century ago. It will be many years before the influence will mature and become apparent or measurable. Nevertheless, we do not crave progress or development at such a price as war.

We must recognize, however, that severe disturbances are very effective in dislocating fetishes, for instance. So, one of the phases of this struggle which is noteworthy is the public awakening to consciousness of the power of chemistry and the universal distribution of the ability to use it promptly and effectively, as against the old idea, that this power and this ability is possessed by a chosen few. An illustration or two will perhaps show that this latter idea is still too prevalent.

I have met manufacturers since the war, whose operations were brought to a full stop by lack of some raw material or other who complacently accepted their fate on the ground that they could not get a German chemist. They had no bias in favor of Germany at all. They just thought it was a matter of common information that chemists were domestic animals imported from the Black Forest. Would you believe that some of these manufacturers were engineers graduated from some of our large colleges of engineering and not men without education?

In such a time as this we see that our keeping quiet about the progress and development of American chemistry in years gone by, was criminal, for much harm results from lack of information as well as from misinformation. There are always patriotic Germans and others who praise their country's achievements to us and as I pointed out last year in SCIENCE, we are glad to see this and our university teachers of chemistry have been lavish in their praise, particularly of German chemistry. They, however, are not rendering very good service to the community when, as they should, they give such praise, if they fail to make a real effort to find out also, what is going on in their own country. We university professors feel abused if it is inferred that we are not well informed, yet we innocently assume as the only modern development in chemistry the latest tale of achievement from a German dye advertisement and these lads know how to use the educated public and university chemistry professors as well, in furthering their advertising propaganda. Much good work has been done by the *Journal of Industrial and Engineering Chemistry* in publishing a series of articles by authorities on what the American chemist has done for the in-

dividual industries. Time only will eradicate the evil. Only a short time ago I was at a banquet of a society of engineers in an eastern city. The professor of chemistry from a near-by university was an invited speaker. He was a revered and respected man among American chemists and a man of affairs, too, but he lived in the dark ages of chemical achievement. He spent half of his time telling how wonderful chemistry was and how great the achievements of foreign chemistry in particular and not one word of American chemistry. Yet in his own city in the last three years has sprung up a chemical industry that is marvelous, and which he did not know existed. In his own line, organic chemistry, was a plant for making certain organic materials used in war, by a series of steps that has no counterpart in chemical literature for the magnitude and conception of its chemical engineering operations. It is not only the largest scale upon which all of its many operations have ever been conducted, but its chemistry is a series of highly interesting adaptations and developments. When peace comes again, if that plant still prospers it will be a useful aid in the solution of one of our most important engineering problems of this generation. Americans are not wizards that they do in two years what it took German chemists decades to work into. Such things are only done where the ability exists and the power born of experience in solving similar chemical problems is possessed. It is not right to our students, you who teach, to praise the competitors of our compatriots and never stir ourselves to be informed on what our own countrymen are doing, even if the foreign achievements are served up to us, ready to teach, as paid advertisement of German dye-makers. The German general staff has learned, if others have not, that German chemical achievement which is great, indeed, is no sign that equal ability does not exist elsewhere. The allies and America improvised a munitions industry in two years to match their machine of forty years' preparation. Such an achievement is only the natural result of our present industrial chemical development in America and the allied countries. There is nothing in the rate of American industrial chemical development of which any American need be ashamed.

The progress in industrial chemistry and chemical engineering in the last three years itself, in this country has been wonderful. Let me protest, however, that this is no ground for the philosophy which I understand obtains in some quarters, that war is a desirable, natural, logical or sort of evolutionary benefit. All this progress is in spite of war. War could force us to do nothing we did not possess capacity for before. Because war changes the normal relations between supply and demand, cost and selling price, gives us opportunities to do only what we could do anyway, if the same demand arose from any other cause.

Industrial chemical tendencies during the war have been governed by unusual demands for chemicals from abroad in addition to war drains, healthy home requirements, new demands from industries formerly supplied from abroad or forced to use new raw material by scarcity or high prices, together with speculation, raising prices to unusual levels. This resulted in expansion of existing plants, rapid installation of new ones, hasty perfecting of new processes already slowly maturing and the seizing of opportunities to profit by high prices through erection of small plants for the production of special chemical materials and through the development of processes hitherto existing as possibilities, only, in the minds of chemists. This has greatly extended also the supplying of chemical construction materials and machinery and has increased the opportunities for the

rapid development of inventions in this line. The progress made here alone has been as great as has been accomplished in many individual decades in the past. The importance of this is apparent when we consider that if the chemical engineer had at his disposal as efficient apparatus and materials of construction in his plant, as exist in the chemical laboratories of the present day, or as the mechanical and electrical engineers have in their work, progress in the arts would be at least a hundred years ahead of its present development.

The tendency to manufacture at the market is another good development which has been greatly accentuated by the war. For some time there has been a growing tendency for manufacturers who are large consumers of chemicals to produce these chemicals themselves. Assisted by gradual price elevation, this tendency has been greatly encouraged by the invention in the last two decades of processes and machines of merit which could find no sale as such, in well-established chemical manufacturing plants, because they frequently offered insufficient advantages to warrant discarding those already operating, or were merely alternative in their character. A good example of how this tendency to manufacture at the market works out normally where the impelling force is merely gradually advancing prices, competition preventing excessive elevation, is to be seen among others in the case of bleach for paper manufacturing. Consumers of alkali and bleach, such as progressive paper manufacturers, operating on a large scale, and others have experimented for years with inventions for the electrolytic production of these materials from common salt. Our present high development in this branch of chemical industry is in no small degree due to these individual efforts, many of which during the past twenty years have been eminently successful. High prices and poor deliveries in the last two years have forced matters to a head in this direction. Where formerly we had a few large chemical plants manufacturing caustic soda and chlorine for bleach by electro-chemical means, we now have distributed throughout the country a great number of concerns who have added to their equipment a plant for the production of these products. The operation of these units under widely diverse conditions will greatly enrich our chemical engineering experience. A number of cell types are obtainable which operate economically. Some of these are well advertised in the current literature, but some, though equally successful, such as the Allen-Moore, Gibbs and Nelson cells are not so well known. The cell portion of such a plant is only a fraction, however, of the equipment required and it is important that the rest of the plant should be properly designed. The simpler and more durable, therefore, the design of apparatus, the more satisfactory the entire equipment will be. There has been placed in operation in some eight plants recently a total of nearly 2,000 cells of one type alone, with a daily capacity of 200,000 pounds of chlorine gas. Some plants constructed this year cost as much as a half million dollars. These will be valuable for defense, for we use much chlorine in making guncotton or nitro-cellulose, for mines and smokeless powder.

This use of alternative inventions is valuable in encouraging new invention and much industrial chemical investigation, and alleviates to some extent the ill effects of unwarranted increase in selling prices.

Progress in Chemical Engineering may be illustrated perhaps best by the progress in acid-making equipment. High pressure manufacturing of chemicals and difficulty of obtaining supplies has brought rapid improvements and development of chemical engineering materials by compelling large

scale experimentation on new products and substitutes. To resist corrosion by acid and other chemicals, pottery or so-called chemical stoneware, glass and natural stone apparatus have been used heretofore. This necessitated small-sized apparatus, and meant in the case of stoneware a manufacturing time of about two months for the clay working, drying and cooling after firing. Attempts have been made for many years to replace this material by metal. Platinum, silver and gold are used in special cases, but while these metals can be made into any size apparatus, cost is prohibitive for most uses. Two classes of alloys have now been developed: rare metal alloys such as tungsten, chromium, or nickel irons, and more recently the cheaper and more resistant silicon-iron alloys. Extensive trials in the last two years have shown the usefulness of these alloys though they do not possess quite the resistance of stoneware to corrosion. They are known under varying trade names, such as durion, made here in Ohio, tantiron and ironac. They are very resistant to all strengths of sulphuric and nitric acids and are used with great satisfaction in their manufacture and permit plants to run for months without shut-down. The success of the modern tower system displacing platinum for concentrating sulphuric acid had been largely due to the use of pipes and fittings of this alloy. Early in 1915 the demand for nitric acid for war purposes increased to enormous proportions, resulting in extensions to old nitric acid plants and the erection of new ones larger than the world had ever seen. Deliveries on stoneware jumped to six months and even longer and had the production of nitric acid been dependent upon stoneware alone, as a few years ago, it would have been greatly curtailed and the story of the great war would have been different. As these alloys can be secured on short notice, the same as cast iron, chemical manufacturers do not hesitate, if a still should run wild and froth sodium sulphate into the condenser, to direct workmen to break the connections at once with a hammer and allow the expelled material to flow on the floor, thus preventing the wrecking of the condensing apparatus. New castings can replace the broken one at once. Such extravagant handling of the material would not be possible under the usual slow deliveries with stoneware. This freedom from risk of damage to condensers, and the making of condensers themselves of this material, enables stills to carry a heavier charge and operate at greater speed. Where the old equipment charged 2,000 pounds once or twice in 24 hours these wartime stills operate on 4,000 pounds of nitre plus 4,000 pounds of sulphuric acid, charging three times per 24 hours. The alloy is somewhat brittle, but very much less so than chemical stoneware. It is easy to see these silicon-iron alloys are a boon to the acid industries and thousands of tons of casting are in use and new chemical processes are possible and now in operation, too, which could not exist before, because of lack of suitable material of which to construct apparatus. Some of these new processes are having a decided value in the Allies' campaigns. No single development in many decades has had as much influence as this one has and will have, for it is only in its infancy.

I need not weary you with other illustrations of progress, though much has been accomplished in many lines and radically new chemical processes developed. The most wonderful and greatest chemical works I have ever seen have been erected in this country since the war began and the best of them were coal-tar dye and synthetic organic chemical works. Reasonable progress has been made in American laboratory glass and porcelain. After the war we are

going to be independent of importation in gross coal-tar products and practically, if not entirely, in ammonia for fertilizers. We are also weeding out the unnecessary use of potash where it replaces soda due to our own careless teaching of chemistry in speaking of and using potassium compounds where sodium serves as well. German potash exporters and others, such as for Saxony manganese, after the war will have an expensive campaign to win us back to these former unwarranted uses of their product.

The relation of chemistry to national defense has been rendered clear by the war, a service of no mean magnitude.

Explosives and asphyxiating gas manufacture are dependent upon labyrinthian chemical engineering operations. It is obviously necessary for adequate preparedness that this country should be self-contained and not dependent upon importation for such supplies as nitric acid, toluol and sulphuric acid for defense. We have the sulphur and pyrites for sulphuric acid. The toluol and other coal-tar products we have ample for our usual needs, but in time of war toloul becomes the basis of "T. N. T." or trinitrotoluol, one of the most effective high-power military explosives. The erection of new coke oven plants has but partially met the demand for toluol in the last two years. In defending ourselves this would be too slow, for such installations are difficult to get under successful operation in less than a year. A large and well-established dye industry, therefore, is vital for defense, for it would produce a bigger demand for coal-tar products and toluol production in peace times and its operations are quickly convertible into ones for producing high explosives. It is to be hoped, therefore, that the German alliance with our textile manufacturers may be broken up during this war so that Congress will be less helpless in fostering this dye industry as a matter of defense than it has been in the past. The expense of storing within the country nitrate of soda imported from Chili, adequate for the nitric acid of munitions production in case of war, would tie up millions. The government will establish a plant to make nitric acid from the atmosphere. The Norwegian process (electric arc) is stated to require five times as much power, a vital factor, as is required in the making of nitric acid from cyanamide. Germany has installed, for making cyanamide, during the war, additional equipment costing $100,000,000, utilizing over 60,000 horse-power and producing about 200,000 tons per year of nitric acid, requiring the most feverish activity for a year and a half on the part of her chemical engineers. We have some American suggestions which if successful will take less power than the German method. Any method for nitric acid producing ammonia also, is desirable as an aid to agriculture. Prices asked for power are much higher than abroad, and as the cost of the engineering is only about 10 per cent. of the total charges in electric power installation, it becomes evident that efficient national defense and economic agriculture depend on more economic banking methods. So in every instance we are confronted with the problems of peace when working out national defense. It should be remembered that our usual source of nitrogen derivatives, the ammonia of by-product coke, brings with it the indispensable toluol, and no electrical method does this. Before the government nitrogen plant is built, therefore, it should be a matter of serious inquiry whether the government's $20,000,000 might not bring the same result and give a liberal supply of toluol besides, if invested in by-product coke expansion, for much of our coke is still made without saving by-products.

It is an open secret that the acceptance of

war orders in this country strained to the breaking point our best organized chemical industries. The mere request by the allied countries two years ago for our soda, benzol, toluol and our explosives for only a *small portion* of their demands, produced a state of affairs in our industries that was an appalling warning against the time when we would need such things ourselves, for defense, and in immensely greater volume.

It is natural, in view of the nature of these defense problems, that the engineers and chemists of the country have been serious in the preparedness movement. Thirty thousand engineers and chemists of the United States volunteered without pay to the National Consulting Board for both the navy and army to work on the organization of the industries of the country for national defense. The result was much more efficient than any similar organization carried out in the world, for no government could afford to pay for the expert services involved. This consulting board and its successor the National Council for Defense, have assisted the country to become self-contained for defense, arranged for speedy conversion of industrial plants into munitions plants and arranged during peace to prevent useless waste of experienced engineers. Experienced chemical engineers, for instance, like naval officers, can not be trained in a day or a year, though the analytical chemical control can be taught in a few days to any chemist. The mistakes made by Britain in passing through the blockade materials helpful in explosive manufacture demands that our military authority and foreign office have at its call as wide a variety of chemical experience and advice as possible, and every chemist as well as engineer in this country is now being card indexed.

If we, as scientists, ask ourselves individually what we can do to assist in the general defense of our firesides and our ideals, the answer is do our daily work in whatever field it may be, as though it were the most important single thing in the world and *particularly do our utmost to assist production and those directly engaged in it, whether manufacturing or agricultural.* Then when the government calls upon us for special service we will be ready to attack the problems which only the military arm can formulate for us.

We have touched on sufficient high points to indicate the character of the influence of the war upon chemistry in America. Still other points should be discussed, were there time. Hardly any branch of the science but contributes an important service to the national defense as well as our normal benefit.

After all, is not chemistry and science itself a pretty matter in the presence of this world calamity and the personal suffering ever upon our minds? Have we not often wondered what we had done to be spared to this minute, from such things? It may be proper to say we do not quarrel with the German people as such, but with the ideals and acts of their leaders and government. Do not let that point of view toward our neighbor, however, be used by us to excuse our individual responsibility for this government and its every act. We are responsible, and we alone. We have seen conclusive proof in the last three years that science and education are merely aids and not specifics against international immortality and that the devotees of science are as easily misled as others when the leaders too are scientific. Though this war has long become evident as a war for privilege and the exploitation of the weak by the strong, and the doctrine that the state *can* do no wrong rather than that the state *must* do no wrong, let us not deceive ourselves that our abolition of aristocratic government is a specific for this malady, for it is not. This is our constant battle still, even under our form of government.

It has become so evident in this war that the intelligent and scientific criminal is a terrible menace, and dislodging him at times such a weary and fatal task, that we must find some way of preventing our leaders and groups or classes, whether governmental or industrial, from becoming this kind of danger.

Have we not reached the time when we are willing to turn to the One who ordained civil government for our good, acknowledge that He ordained it and not we ourselves, and make our leaders or rulers "whom God and this people shall choose"—"men fearing God and hating covetousness"?

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SCIENTIFIC EVENTS

THE JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION

ACCORDING to the annual report of the trustees of the American Medical Association the principal expense in the publication of *The Journal* is that of paper, this expense being one third of the total expenses. The price of paper began to go up rapidly in the spring of last year. About June and July, book paper was almost unobtainable and commanded a price three or four times what was being paid, the low rate prevailing for the entire year 1915, the cost of paper being approximately $116,000. In 1916 the cost of paper was approximately $134,000—an increase of about $18,000 over the preceding year. It is estimated that for the present year, 1917, the paper will cost about $170,000. This means an increase in 1917 over last year of $37,000, and of $54,000 over 1915.

These new conditions presented problems to the board that had to be met. It was necessary to increase the annual subscription price, decrease the size of *The Journal*, or get along with decreased income. Increasing the subscription price was not possible. But the size of *The Journal*, it is said, can be reduced without seriously lessening its value or its usefulness to its readers. The number of fellows of the association receiving *The Journal* has been as follows:

1900	8,445
1901	9,841
1902	11,107
1903	12,553
1904	13,899
1905	17,570
1906	20,826
1907	26,255
1908	29,382
1909	31,999
1910	33,032
1911	33,540
1912	33,250
1913	36,082
1914	39,518
1915	41,254
1916	41,938
1917	42,744

The above figures do not include honorary fellows, nor those fellows who have substituted *The Archives* or the *Children's Journal* for *The Journal* of the American Medical Association.

APPROPRIATIONS FOR CORNELL UNIVERSITY

GOVERNOR WHITMAN, of New York state, has signed the annual appropriation bill which provides for the expenses of the two state colleges at Cornell University during the coming fiscal year, from July 1, 1917, to June 30, 1918.

We learn from the Cornell *Alumni Weekly* that the bill carries for the State College of Agriculture $779,401. Of this amount $35,750 is to provide for specific deficiencies in appropriations made by the two preceding legislatures. The present legislature had already passed, some six weeks ago, an emergency item of $55,910 for the College of Agriculture to enable it to carry on its work during the current year in view of the reduction in the general appropriation bill a year ago. When this emergency item is added to the general appropriation bill just passed it makes a gross appropriation provided by the present legislature of $835,311 as against a gross appropriation of $518,325.66 made by the 1916 legislature, or an increase of $316,985.34. When, however, the

emergency and deficiency items, which together amount to $91,660, are subtracted, there is left a net appropriation of $743,651 for the year 1917-18.

In addition to the above appropriations the general appropriation bill this year provides a specific item of $42,000 for printing the publications of the College of Agriculture. Heretofore no special appropriation for printing has been made, but the college printing has been paid for out of a lump appropriation known as the legislative printing fund. The printing for the next fiscal year must be limited to the amount of this specific item.

Included in the $743,651 in the general appropriation bill are a number of small items, of which the aggregate sum is $34,000, for new construction and improvements. The largest of these is an appropriation of $12,000 for the addition of a unit to the central heating plant. When this unit is installed the old heating plant in Roberts Hall is to be removed and the boiler room remodeled to provide additional space for the general purposes of the college. An item of $8,000 is included for remodeling this boiler room. To put in additional roads, sidewalks and drains and general improvements to the grounds, $5,000 is provided; for a new piggery with detached pens, $7,000; for a packing shed on the pomology grounds, $1,000, and for small storage houses for the department of plant breeding a small item is included.

AN INSTITUTE OF APPLIED OPTICS FOR FRANCE

MR. E. S. HODGSON writes in *Nature* that a scheme is on foot in Paris to establish an Institute of Applied Optics, with the object of securing closer cooperation between theory and practise in the optical trade. It has been suggested, according to an article in *La Nature*, that the scope of the institute should fall into three sections, viz., (i) a college of optics, providing a thorough theoretical and practical training for opticians, and promoting among its students a taste for optical research; (ii) a central optical laboratory, where tests of glasses and optical instruments would be made for men of science, public bodies and manufacturers and research work of general interest carried out; and (iii) a special trade school in which the students could obtain a thorough training in the practical branches of the trade.

It is proposed that the institute should publish transactions in a form following, the *Zeitschrift für Instrumentenkunde*. The students of the college of optics would be recruited from the educated classes—army and navy officers, students or ex-students of the universities and technical colleges, astronomers, illuminating engineers, manufacturers of optical instruments and doctors interested in physiological optics. There would be two distinct branches of instruction, viz., general optics and instrumental optics. The courses would be supplemented by lectures on all modern optical questions. The period of study is suggested as one year.

The central laboratory would serve as a test laboratory for manufacturers of optical instruments and for glass manufacturers, as a practise laboratory for the students, and as a research laboratory for the college staff.

The professional, or trade, school would take young people for three years and give them a thorough training in (i) glass-working, and (ii) construction and fitting up of optical instruments. The scheme has received the favorable consideration of various government departments and of certain scientific and learned societies in Paris; indeed, the publication of the transactions of the institute is already assured. While it would be difficult to install the machinery and plant necessary for the trade section of the institute, it is suggested that the program of the courses should be considered and the principal courses commenced in the school year of 1917-18.

THE CROCKER LAND EXPEDITION

DR. HARRISON J. HUNT, a member of the Crocker Land expedition, arrived in Copenhagen on June 2, reporting the expedition still in northern Greenland. Direct news from Donald B. MacMillan, head of the expedition, announcing that he and his companions had only enough supplies to last them until August of this year, has now been received by Dr. Henry Fairfield Osborn, presi-

dent of the American Museum of Natural History. Mr. MacMillan reports that both the relief vessels sent to his aid, the *George B. Cluett* and the *Danmark*, have failed to reach him and urges that a third be sent, as otherwise the party will be obliged to adopt Eskimo methods and live on the country.

George H. Sherwood, acting chairman of the Crocker Land Committee, composed of representatives of the American Museum of Natural History, the American Geographical Society and the University of Ilinois, announces that the steam sealer *Neptune* will be sent with all possible dispatch. This third effort to reach the party in the frozen north will cost at least $40,000, provided that the *Neptune* is able to reach the base at Etah, Greenland, and return by September next. The Committee hopes that in view of the extraordinary expenses it will receive substantial financial aid from the public. From the scientific point of view, the results of the expedition fully justify the heavy cost, it is said, although Crocker Land, which Rear-Admiral Peary thought he saw, has proved a land of mirage. Among other things, the party has discovered six new islands and mapped and explored Finlay Island, seen more than sixty years ago by Sir John Franklin, and yet never, so far as is known, actually visited by man.

The Crocker Land Expedition went north in 1913. Doctor Hovey, as chairman of the committee-in-charge of the expedition, left New York in 1915 to carry aid to Mr. MacMillan. He was in charge of the steamer *George B. Cluett*, which was chartered from the Grenfell Association. The *Cluett* reached North Star Bay in September, 1915, but, owing to the formation of ice, could not proceed further north. In this emergency Doctor Hovey proceeded a hundred and fifty miles to the headquarters of the expedition at Etah. Three members of the Crocker Land Expedition managed to reach Holstenberg in south Greenland and from there took ship for Copenhagen. Dr. Hovey remained with the Crocker Land party. In response to an appeal from him, the committee chartered the steamer *Danmark* from the Greenland Mining Company and dispatched her north to the relief of the party. The *Danmark* was reported on August 20 last buffeting the ice in Melville Bay.

SCIENTIFIC NOTES AND NEWS

Dr. Arthur Dean Bevan, of Chicago, was elected president of the American Medical Association at the meeting held in New York City last week. The meeting of the association next year will be at Chicago.

In honor of Dr. J. J. Stevenson, emeritus professor of geology in New York University, the faculty club house will be known as Stevenson Hall. One of the residences on the campus has been converted into a faculty club house, the equipping of the building for that purpose being done by the class of 1902.

Professor James F. Kemp, since 1891 professor of geology in Columbia University, has retired from active service owing to the impairment of his health.

Base Hospital No. 5, the Harvard Medical School unit, is reported as having arrived in Paris. Major Robert U. Patterson is in command of this unit, of which Dr. Harvey Cushing is director. Professor W. B. Cannon accompanies the unit to make investigations on the cause and treatment of "shock." Mr. McKeen Cattell is assisting him.

Dr. Livingston Farrand, president of the University of Colorado, will shortly go to France under the auspices of the Rockefeller Foundation to undertake work for the control of tuberculosis.

Columbia University has conferred its doctorate of science on Dr. George E. Hale, director of the Mount Wilson Solar Observatory, on Dr. Robert A. Millikan, professor of physics in the University of Chicago, and on Mr. Guglielmo Marconi.

New York University has conferred the degree of doctor of laws on Dr. Charles S. MacDonald, the alienist, and on Mr. Theodore N. Vail, president of the American Telegraph and Telephone Company.

Dr. Raymond Dodge, professor of psychology at Wesleyan University, has been appointed to

the Ernest Kempton Adams research fellowship at Columbia University.

DR. M. C. MERRILL, who has done graduate work at Cornell, Chicago, Harvard and Washington universities, and who has been director of the department of agriculture of the Idaho Technical Institute for the past two years, has been appointed horticulturist at the Utah Agricultural College. He will take up his work at Logan on July 1.

DR. ISADORE DYER, of Tulane University, has received an appointment as major in the Medical Officers' Reserve Corps.

DR. EDWARD R. BALDWIN, director of the Saranac Lake Laboratory, delivered the annual address before the Alpha Omega Alpha Honorary Medical Fraternity at Western Reserve Medical School on May 14. The subject was "Latent tuberculosis, its importance in military preparation."

ARNOLD LOCKWOOD FLETCHER, research assistant in geology at Trinity College, Dublin, has been killed in the war.

DR. FELIX LE DANTEC, professor of tropical pathology in the University of Bordeaux, died on June 7.

ACCORDING to *Nature* progress has been made with the proposal to establish a national memorial to the late Captain F. C. Selous, killed in action while leading his men in an attack on a German post in East Africa early in January last. An influential and representative committee has been formed under the chairmanship of the Rt. Hon. E. E. Montagu, M.P., with Mr. E. North Buxton and the Hon. W. P. Schreiner, C.M.G., as vice-chairmen. Among others who have joined the committee are Viscount Buxton, G.C.M.G., the Earl of Coventry, Dr. David (headmaster of Rugby), Lord Desborough, Viscount Grey, Colonel T. Roosevelt, Lieutenant-General J. C. Smuts, and representatives of the Royal Geographical Society, the Zoological Society, the Entomological Society, the British Ornithologists' Union, the Royal Colonial Institute and the British South Africa Company. The committee has decided, with the permission of the trustees of the British Museum, to place a mural tablet in the Natural History Museum, where many of Selous's finest trophies are exhibited. There is a general desire that some additional form of perpetuating his memory should be established. It is therefore proposed to found a Selous scholarship at Rugby (his old school), for the sons of officers, primarily of those who have fallen in the war.

THE *Journal* of the American Medical Association states that Major Hugh-Hampton Young, M. R. C., Baltimore, director of the James Buchanan Brady Institute at the Johns Hopkins Hospital, has been selected to head the special mission under the direction of General William C. Gorgas, Washington, D. C., and the Council of National Defense that is to study medical necessities at the battle front, and will have entire charge of the medical care of the American Army in France. Dr. Young has already started on his mission and on his arrival in England will report to Surgeon-General Sir Alfred Keogh. He and his staff will also report on the advisability of establishing in this country a hospital for the care of wounded and disabled American soldiers who may have to be sent home. Dr. Young will be accompanied by Captain Louis C. Lehr, of Georgetown University, Captain Montague L. Boyd, of Emery College, Atlanta, and Lieutenant Howard L. Cecil, of the Brady Institute, Johns Hopkins Hospital.

THE *British Medical Journal* states that Mr. Alfred T. Davies, of the Board of Education, has written under the title "Student Captives" a short account of the British prisoners of war book scheme (educational), whose object is to provide British prisoners of war interned in enemy or neutral countries with educational books. His pamphlet shows how much trouble has been taken by the committee to provide the prisoners with mental interests, and to make suitable provision for their education so as to enable them to redeem the time of their captivity. It includes letters of approval from Lord Crewe and the president of the Board of Education. Letters of inquiry should be addressed to A. T. Davies, Esq., C.B., Board of Educa-

tion, Whitehall, London, S.W.L., and the words "Prisoners of War" written in the left-hand top corner.

The Eugenics Research Association will hold its next annual meeting on June 22 and 23, in conjunction with the annual conference of field workers of the Eugenics Record Office. The sessions of Friday will be held at Cold Spring Harbor and that of Saturday morning at the rooms of the Brooklyn Institute of Arts and Sciences.

A new volume, the seventh, of the exhaustive report on the extensive and valuable phosphate deposits of the Russian Empire, was issued last year. This gives the results of investigations carried on during 1914; since the outbreak of the war the activity in this field has, of course, been almost exclusively productive. A general résumé of the results is given in Russian by the editor, Professor J. Samojloff, in a short prefatory section of 25 pages. This is succeeded by the special reports (in Russian) concerning the following localities: the Sisola and Lusa rivers in the Ustsysolsk district, government of Vologda, by V. G. Chimenkoff (pp. 1–32); the Aktjubinsk district by D. N. Sokoloff (pp. 33–60); the Dmitrovsk district, government of Orloff, by G. S. Burenin (pp. 61–124); the basin of the upper Kama in the Slobodsk district, government of Vjatka, by V. G. Chimenkoff (pp. 125–208); the Roslavl district, government of Smolensk, by A. P. Ivanoff (pp. 209–244); the region of the middle course of the river Zna, government of Tamboff, by A. S. Dobroff (pp. 245–312); the Pavlograd district, government of Ekaterinoslav, and the Isum district, government of Charkoff, by G. F. Mirtchink (pp. 313–327); the environs of Lake Indersk, Lbitchensk district, government of Uralsk, by A. N. Zamatin (pp. 327–332); the north part of the Temir district, government of Uralsk, by A. N. Zamatin and P. M. Vasiljeuskij (pp. 333–372); the northwest part of the government of Kursk, by A. N. and B. N. Semichatoff (pp. 373–456); the region of the lower course of the river Amudarja, by A. D. Archangelskij and B. N. Semichatoff (pp. 457–518); the Mosalsk, Metchovsk and Jisdra districts, government of Kaluga, by A. P. Ivanoff (pp. 519–546). The book concludes with "Contributions to the Mineralogy of Phosphates," by J. V. Samojloff.

The heirs of the late R. J. Lechmere Guppy, of the island of Trinidad, who died August 5, 1916, are offering for sale his large collection of shells and his extensive library, gathered during a period of more than fifty years' residence in Trinidad. A detailed manuscript catalogue has been submitted to the Smithsonian Institution with the request that it be open to inspection.

EDUCATIONAL NOTES AND NEWS

On June 2, Governor Ferguson vetoed the entire biannual appropriation for the maintenance of the main University of Texas at Austin and the medical department at Galveston. The amount involved is about two millions. The governor took this action after he had failed to force the board of regents to dismiss without proper cause the president of the university and several other members of the faculty. Unless some other means of support can be found, this action will force the University of Texas to close its doors for the next two years.

A chair of legislation in the law school of Columbia University has been endowed with the sum of $150,000 by Mr. Joseph P. Chamberlain. Dr. Thomas I. Perkinson has been appointed the first incumbent of the chair.

The sum of a hundred thousand dollars has been bequeathed to the University College of South Wales by the will of the late Dr. William Price.

Colonel Samuel E. Gilman, a member of the faculty of the West Point Military Academy, has been appointed superintendent to succeed Colonel Biddle, who has been assigned to the command of the Sixth Regiment of Engineers for service in France.

Professor William Chandler Bagley, Ph.D., director of the school of education of the University of Illinois, has been appointed professor of education in Teachers College, Columbia University.

GEORGES VAN BIESBRECK, of the Royal Observatory of Belgium, has been appointed assistant professor of practical astronomy at the University of Chicago.

PROFESSOR H. L. WHITE, formerly connected with the North Dakota Agricultural College, who is spending the present year in graduate work at the University of Wisconsin, has been elected professor of biological chemistry in the college of physicians and surgeons, medical department of the University of Southern California, at Los Angeles.

ASSOCIATE PROFESSOR WILLIAM DRAPER HARKINS has been promoted to an assistant professorship of chemistry in the University of Chicago.

IN the department of anatomy of the college of physicians and surgeons, Columbia University, Dr. Oliver S. Strong and Dr. Vera Danchakoff, have been appointed to be assistant professors.

DR. HARRY CLARK, instructor in physics at Harvard University, has been appointed professor of physics at Victoria College, Wellington, New Zealand.

DISCUSSION AND CORRESPONDENCE

THE CENTRAL ILLINOIS TORNADO OF MAY 26, 1917

A TORNADO crossed Central Illinois from Pike County on the western side of the state almost directly east into Vigo County, Indiana, then bent southeastward into Monroe County, Indiana, on the afternoon of May 26, 1917. The tornado was responsible for the deaths of over 100 people, a large quantity of live stock, and the destruction of farm buildings and other improvements, railroad cars, and portions of a number of towns.

The greatest destruction was wrought in Coles County, Illinois, where it struck the residential districts of the workmen of the cities of Mattoon and Charleston—the former a city of 15,000, and the latter a city of 6,000. The tornado passed through this county between three and four P.M., *i. e.*, that part of the day in which tornadoes are generally most effective. Sixty people were killed, 500 homes demolished, and others seriously damaged in Mattoon at 3:30 P.M. Travelling at about 45 miles per hour the storm struck Charleston, 11 miles east of Mattoon at 3:45. Here, 34 were killed, over 400 homes more or less demolished, 15 industrial establishments partially or wholly destroyed, and two railway stations wiped out.

The track of the storm is about 225 miles long, but the length of the path in which almost complete devastation was wrought is about 40 miles. The width of the storm track varies from one fourth to one half mile, with an average of about one third of a mile. In numerous places minor damages resulted over an area about three fourths of a mile wide to the south of the track. The storm's path indicates that the tornado swerved slightly in some places and in others raised to the extent that serious effects did not result.

Destruction was most complete, in fact entirely complete in a zone from 500 to 700 feet wide to the right of the storm center's track. The parts of the two cities that were in this part of the storm track, with the exception of the heavier industrial buildings of Charleston, were more completely demolished than if a gigantic roller had passed over them, for the buildings were broken into short sticks, split into narrow pieces, and some parts carried rods and even miles eastward. Inspection shows three zones of variable destruction: First, the one of complete devastation; second, a zone from 300 to 500 feet wide to the left of the storm center's track and a similar one of similar width to the right of the devastated zone, where buildings are demolished beyond repair but not razed; and third, a zone still further to the right of the center where damages decrease outward from buildings moved to lifted roofs, fallen chimneys, and broken windows. Objects to the right of the center were moved forward and in, while objects to the left of the center were moved backward and in. Trees which were probably near the center were felled either north or south.

The reason for the location of the area of

complete devastation being to the right of the center seems to be plausibly explained when the agents of destruction are considered. On the right of the center there is the explosive action due to the reduced pressure on the outside of the buildings, the eastward component of the counter-clockwise wind of the tornado (probably over 400 miles per hour), the forward movement of the storm, and the west wind which was prevalent at that time all working in conjunction as agents of destruction; while on the left side of the center the westward component of the counter-clockwise wind is partially counterbalanced by the forward movement of the storm and the prevalent west wind. However, the backward or east wind of the storm was strong enough to move an eight room, one story house 41 feet to the westward, others shorter distances, to break elm trees 18 inches in diameter and to tip over a large percentage of the monuments in a cemetery in Mattoon.

Evidence of the explosive action so frequently stated as the principal agent in tornado destruction is not as general as one would expect. The north ends and the east roofs were pulled from some houses in the partially demolished districts; plate glass windows were broken and had fallen out; in one of the churches and a store in which the glass was supported by metallic strips the windows were made convex; a pump and 14 feet of water was sucked from a well; these, and the various forms of roofing which were picked off like feathers from a fowl, indicate the suction action of the storm. Although examples of explosion are not common, it is quite probable that in and near the center of the storm explosion was a big factor in the preparation of buildings for the crushing action of the wind.

Blunt cedar sticks were found imbedded one and one half inches in posts, and oatstraws one half inch in a maple tree. Another tree was decorated like an Indian's helmet with feathers. Huge oak and elm trees were twisted off, freight cars filled with brick were upset, as were also the tank cars of the Standard Oil Company. These and the buildings moved and crushed indicate the force of the wind of the storm.

METEROLOGICAL CONDITIONS

The *Daily Weather Map*, published at St. Louis at seven A.M. of the date of the storm, shows a well-defined cyclonic area covering most of the interior lowland of the United States. The isobars are oval in shape with their longest axis extending north and south. The isobars also show a slight bulging to the south in the southern quadrant. Cloudiness was prevalent over most of the Mississippi valley.

At 11 A.M.[1] a thunder shower occurred at Charleston. The clouds broke for a short time but lights were necessary at 2 P.M., and the air was exceedingly sultry and oppressive. At 3 P.M. a heavy, black, nimbus cloud appeared in the northwest, and frequent and fierce flashes of lightning occurred. Shortly before 3:45 a greenish black cumulo-nimbus cloud began to tumble in from the west. The wind suddenly changed from east to west through the south and hail began to fall. Then the hail lessened in amount and the wind attained a velocity of eighty miles per hour, the barometer dropped three tenths of an inch but came up immediately, and the temperature fell fourteen degrees. (Shown by the barograph and thermograph records.) Suddenly the wind lulled and flattened spheroidal hail, some having a major axis of 2¼ inches, fell until the ground was covered. The hail was accompanied and followed by a deluge of rain.

Although the funnel or balloon-shaped cloud of the tornado was not visible to those in the cities, it was seen and well described by numerous individuals who were west of the cities and to the right or left of the storm.

J. P. Carey

Department of Geography,
Eastern Illinois State Normal School,
Charleston, Illinois,
June 4, 1917

[1] Observations made at the State Normal School, Charleston, one mile to the south of the storm track.

SCIENTIFIC BOOKS

Theoretical Chemistry. By WALTHER NERNST. Trans. from revised seventh German edition by H. T. TIZARD. New York: The Macmillan Company, 1916. 23 × 15 cm.; pp. xix + 853. Price, $5.00.

This is a translation of the seventh German edition and as such is welcome. It would have been more welcome, however, if the publisher and the translator had been courageous enough and enterprising enough to have issued the volume some years ago. As it is, everything in the book is at least five years old and, in addition, the translator says: "The character of the work is slowly changing, since it is no longer possible in a book of this size to describe fully all the modern developments of theoretical chemistry. The new matter in this edition is therefore concerned mainly with Nernst's own researches. For example, there is a very interesting and clear account of the modern theory of solids, but, on the other hand, practically no mention of the recent advances in radio-activity and the atomic theory. These inevitable restrictions will hardly detract from the value of the book."

This is certainly a very tactful way of saying that Nernst is not willing to take the trouble to revise any parts of the book except those dealing with his own researches. In spite of the impossibility of describing fully the modern developments the translator has induced Professor Tutton to bring up to date all sections in the book dealing with crystallography.

In looking over a book like this, one is struck with passages which would have escaped notice three years ago. On p. 156 Nernst deduces that the osmotic pressure of a substance in mixed solvents follows the gas laws. He states that the resulting formula was verified satisfactorily by Roloff and then points out that the addition of potassium chloride to aqueous acetic acid may raise the partial pressure of the acetic acid. Most of us believe in some things which we know are not so; but it takes a special type of mind to claim that we have proved a thing in the same breath that we mention facts which disprove it. The case is not so striking on p. 707 where Nernst formulates the generalization that if two phases are in equilibrium with a third phase at a certain temperature with respect to a certain definite reaction, they are then in equilibrium with each other at the same temperature and with respect to the same temperature. This differs from the preceding case because no data are given to show the inaccuracy of the theorem. Nernst knows as well as anybody that an aqueous solution saturated with respect to sodium chloride is not in equilibrium with an alcoholic solution saturated with respect to sodium chloride at the same temperature; but the glamour of the phrase is upon him and he does not analyze it to see that what he has said is not the same as that two things which are equal to the same thing are equal to each other, though it may sound like that. This curious mixture of keenness and self-delusion is no longer an isolated phenomenon. We now know that it is a national weakness.

On p. 570 Nernst is quite willing to state that methyl orange is a basic indicator and that the acid function of methyl orange is unimportant as regards change of color; but he will not mention the fact that Ostwald holds an entirely different view. The people who read Ostwald's books also never learn that anybody questions the opposite view. It would be incompatible with the dignity of either to admit that he was wrong. Consequently the student who reads one set of text-books learns one group of facts as unquestioned, while he who reads another set of text-books learns another group of facts without any suspicion that these things are not accepted universally. Incidentally, it might be mentioned that Kahlenberg's name does not appear anywhere in the book and that there is no reference anywhere to any of the objections raised by Kahlenberg.

While one may object seriously to the order in which the subject is presented and to the spirit in which the book is written, there is no gainsaying the fact that Nernst is an ex-

tremely able man and that his book contains a great deal of valuable information. The mere fact that it has been through seven German editions is proof in itself that people read it. There is a fine sound to the subdivisions of the book: the universal properties of matter; atom and molecule; the transformation of matter; the transformation of energy. What could be better than this? When a man sandwiches a chapter on colloidal solutions in between one on radioactivity and one on the absolute size of the molecules, one is almost tempted to forgive him for talking about the enormous molecular weights of substances in the colloidal state. In a great many chapters what Nernst has to say is very well worth while and of course it is not fair to read the parts on colloid chemistry, photochemistry, and flame spectra in the light of what one now knows. It is possibly the war, though I think not; but the whole tone of Nernst's book grates on one, perhaps more when it is presented in English than when one reads it in German. The contrast between this book and van't Hoff's Lectures is very striking.

The translation is very much better done than has been the case in most of the previous English editions. Either the translator or the proofreader has been very careless, however, in regard to proper names, many of which are misspelled.

WILDER D. BANCROFT
CORNELL UNIVERSITY

SPECIAL ARTICLES

THE MEASUREMENT OF LIGHT IN SOME OF ITS MORE IMPORTANT PHYSIOLOGICAL ASPECTS

THE principal relations of light to organisms include the following phases of its action:

1. Photosynthesis, in which specialized protoplastic masses containing chlorophyll elaborate carbohydrates from carbon dioxide and water. The well-known absorption bands of chlorophyll in the red and in the blue are taken to indicate the portions of the spectrum concerned in this action.

2. Influence of illumination on transpiration and water content. It is probable that the red end of the spectrum chiefly furnishes the wave-lengths which cause changes in temperature, and variations in water loss.

3. Influence of illumination on the respiration and other metabolic processes in protoplasm as induced by the photolysis of substances important to the life of the organism.

4. Coagulatory, neutralizing or disintegrating action of light or toxic effect of products, especially of the shorter wave-lengths, on living matter as exemplified by the fatal effects of blue-violet rays on minute organisms.

5. Tropistic reactions, in which the position of the axes or of the entire body is changed in response to direction or intensity of the rays and with respect to special wave-lengths. Various parts of the spectrum may be active in different organisms.

6. The indirect action of light on rate, course and amount of growth, together with morphogenic reactions. Such effects have not yet been analyzed to an extent which might furnish data for a rational discussion of the direct effects of light on growth. Indirect effects are recognizable.

7. Action of light on environic conditions exemplified in the ionization of the air by the shorter wave-lengths as described by Spoehr.

Experimentation upon any of these subjects requires sources of light under good control, screens for transmitting special regions of the spectrum and methods of measurement of the relative intensity of the illumination falling on the organism.

Sunlight may serve in some work when the requisite screens are available, but incandescent filaments, mercury and amalgam vapor arcs enclosed in glass or in quartz may be used as sources of light down to wave-lengths of .28 μ.

Layers of liquid, pigments in gelatine and other perishable screens have served admirably in some demonstration and research work, but when long-continued exposures to intensities approaching those of normal sunlight are desired a durable screen is necessary. A series of formulæ for a number of glasses which would transmit various parts of the spectrum has been developed in the laboratory of a prominent firm of glass-makers. These may

now be obtained in stamped plates $6\frac{1}{2} \times 6\frac{1}{2}$ inches.

A brief characterization of a few of these is given below:

Red: High transmission in red, removes all light below .61 μ.

Blue: Transmits only blue below .52 μ and may be made deeper to transmit only below .50 μ.

Yellow: High transmission in red and infrared and through green to .48 μ giving about 75 per cent. of incident white light. All ultraviolet absorbed.

Uviol: Transparent to visible spectrum, transmitting ultra-violet to .31 μ in sheets $\frac{1}{4}$ inch thick, to 30 μ through $\frac{1}{8}$ inch thick.

Heat-Absorbing: Absorbs most of infrared and 97 per cent. of heat of Nernst lamp—gives a pyrheliometer reading about half that of good window glass. Transmits 65 per cent. of incident white light.

Formulæ of twenty other glasses are available by the use of which the regions of the spectrum noted above may be modified or different separations made. Desirable effects may also be obtained by combination of two screens. Thus for instance light passing through a yellow of the type described above and the heat absorbing glass loses all the spectrum except the yellow and a small part of the red.

The only thoroughly reliable measurements of solar radiation available to the biologist are those made with the Ångström and Abbot type of pyrheliometer which recorded the total normal insolation in heat units. However, in the blue-violet region of the spectrum, which is of especial interest to the biologist, this type of instrument is not sufficiently sensitive. It is therefore proposed to use the *photo-electric cell* as developed by Elster and Geitel. This instrument has the great advantages of extreme sensitiveness in the blue-violet region and ease of manipulation; it records immediate and directly proportional values, and can be used for extensive ranges of intensities.

A comparison of the results to be obtained by the use of the two methods is afforded by the data given below. Direct sunlight at the Desert Laboratory is taken as 100, and the figures in both cases are percentages of this total. The values from the pyrheliometer were calculated in calories per sq. cm. per minute, and those of the sodium photo-electric cell are from readings of the high sensitvity galvanometer.

Illumination	Proportion of Direct Sunlight (Sunlight = 1.39 Calories per Sq. Cm. per Minute)	
	Smithsonian Pyrheliometer Values	Sodium Cell Values
Direct sunlight at	100%	100%
Transmission—		
Uviol glass	90.2%	86.6%
Yellow glass	53.6%	5.1%
Red glass	42.4%	0.62%
Heat-absorbing glass.	25.4%	63.2%
Blue glass	10.5%	49.0%

These results show a total value of normal sunlight through *uviol* glass transmitting the entire spectrum not being widely different by the use of the two instruments, although the pyrheliometer values are derived from the longer wave-lengths and those of the sodium cell from the shorter ones.

It may be assumed that half of the total energy registered by the pyrheliometer is strictly within the red, which causes but little action in the sodium cell.

The pyrheliometer shows a total of nearly 54 per cent. of the energy of sunlight passing through the yellow screen which transmits from red to and including the blue-violet.

Perhaps the most interesting results are those which are obtained by measurement of light passed through the so-called heat-absorbing screen, which has been found to transmit the visible spectrum except the longer red and infra-red.

The pyrheliometer reading of such a glass is but 25 per cent. of clear sunlight, while the sodium cell records 63.2 per cent. of the total. A notable difference between the recording action of the two instruments in the blue is also evident. It is self-evident that the universal method of calibration of sunlight intensities by the pyrheliometer does not give results which are adequate or correct in all of the various aspects of the physiological effects of light.

Measurement of light from artificial sources has been done chiefly by photometric methods, but it is to be pointed out that the results obtained in this manner are scarcely more adequate than those of the pyrheliometer.

The sodium cell connected with a suitable portable galvanometer offers many advantages for the measurement of light intensities in natural habitats, and a comparison should be made between it and the various photometers and illuminometers which are now being recommended to the forestry student and the ecologist. It seems highly probable that more exact measurements in the blue-violet region so important in photolysis and phototropism will yield information by which some of the current discordant results may be harmonized. In any case the action of the photoelectric cell in light is more nearly parallel to that of the organism than that of any other light measuring instruments hitherto available.

We are indebted to Professor Jacob Kunz, of the University of Illinois, who has very kindly constructed some cells to meet our particular needs and whose advice has been most helpful in the application of this instrument to physiological uses.

D. T. MacDougal,
H. A. Spoehr

Desert Laboratory,
Tucson, Arizona,
March 30, 1917

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 569th regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, April 7, 1917, called to order at 8 P.M. by President Hay with 45 persons in attendance.

Under the heading brief notes and exhibition of specimens Dr. R. W. Shufeldt exhibited lantern slides of living California quail, calling attention to their rapidly diminishing numbers. Dr. L. O. Howard called attention to the cocoon of a *Cecropia* moth containing moon-stones that had lately come to his notice. He expressed the opinion that they had been placed there by a thieving crow or bluejay. Mr. A. Wetmore stated in this connection that he had seen bluejays insert small acorns and kernels of corn into large cocoons.

The regular program consisted of two communications:

A Note on the Hibernation of the Mud-turtle: Alexander Wetmore and Francis Harper.

The authors reported finding a specimen of *Kinosternon pennsylvanicum* shortly after it had left its underground winter-quarters. The hole from which it had emerged was beneath a dense growth of green-briar in an old field and about fifty yards from the nearest marsh. The burrow was 9½ inches deep, and was open save at the lower end, where the animal had apparently lain encased in a mass of mud. The actions and conditions of the turtle after being placed in water were described in detail, and an account of a post-mortem examination of the viscera was given. Messrs. W. P. Hay, M. W. Lyon, Jr., and Wm. Palmer took part in the discussion.

Botanizing in the Hawaiian Islands: A. S. Hitchcock.

The speaker visited the Hawaiian Islands during five months of 1917. He said the trade winds deposit their moisture upon the eastern and northern mountains of all the islands, furnishing the conditions for rain forests in these regions. The lee side of the islands is dry even to aridity. An interesting feature of the wet areas at or near the summit of the ridges are the open bogs. These bogs are devoid of trees and large shrubs, but contain a variety of low shrubs and herbaceous plants. Many species form tussocks, or hemispherical masses raised above the level of the bog. The most conspicuous of the tussocks is made by a sedge (*Oreobolus furcatus* Mann.). Three peculiar species of *Panicum* are tussock-formers (*Panicum monticola* Hillebr., *P. imbricatum* Hillebr. and *P. isachnoides* Munro). Owing to the extreme isolation of the islands the flora is peculiar and interesting. The family Lobeliaceæ is represented by about 100 species, belonging to about 6 genera. Many species are arboreous, forming trunks ten to twenty feet, or in a few cases as much as forty feet high. The crown of foliage gives the aspect of a palm. The grasses, disregarding the introduced species, are not numerous, but several are peculiar. The genus *Eragrostis* is represented by numerous species. A rare species of *Poa* (*Poa siphonoglossa* Hack.) produces leafless rushlike stems, as much as fifteen feet long. His talk was illustrated by maps, botanical specimens and numerous lantern-slide views of various features of the islands.

M. W. Lyon, Jr.,
Recording Secretary

SCIENCE

FRIDAY, JUNE 22, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y

THE SOURCES OF NERVOUS ACTIVITY[1]

I CAN not proceed with what I have to say without speaking first a word of congratulation and thanks to those whose material and intellectual resources have made the Scripps Institution for Biological Research an actuality. Biologists the world over are coming to be more and more dependent for their training and inspiration upon just such establishments as this. The introduction into our institutions of learning of the laboratory with its unique and novel educational methods was indeed a vast step in modern progress, but it can be said in no sense to have rendered superfluous the laboratory designed for pure research. This, from the time of Davy and Faraday, has retained its original function unimpaired and has been the means of directing mankind to many of his most profittable lines of endeavor. Such research institutions, which by a happy concurrence of events have been much on the increase of recent years, must always remain the highest shrines of science. They originate, they conserve, they hand on; and all this is done without the interference of the pedagogue; in other words, their scholarship, to use that term in its best sense, is of the highest order. In them the true spirit of science is better exemplified than in any other type of institution that we possess. It is therefore a time for congratulation when the Scripps Laboratory can open its doors more widely than ever before to those who have reason to make use of its abundance.

It has been in such institutions as this

[1] A dedicatory address delivered August 9, 1916, at the Scripps Institution for Biological Research of the University of California.

that in the past few years I have been conducting studies on the origin of that most intricate and complex systems of organs, the nervous system, and in fact it is to this institution that I have come for a time to continue such investigations. It may not be inappropriate, therefore, if I attempt to tell you in as simple and direct a way as I can something of the problem on which I have been working and of the results that I believe I have attained.

Every one knows nowadays that there is an intimate and important relation between man's intelligence and his brain, that his eyes, ears and other sense organs deliver to him information concerning the exterior, and that by means of his muscles controlled through his nerves, he can mold his surroundings more or less to his liking. But perhaps few persons have realized how strictly nervous all these operations really are. Take, for instance, the apparently simple question of the seat of our sensations. To an untrained person the pain of a pin prick is located where the pin enters his skin. To him nothing seems more obvious and certain than that the punctured spot is the seat of the pain and any attempt to change his view on this point will usually be regarded by him with suspicion and mistrust, for it seems contrary to common sense. Such persons adopt more or less unconsciously the opinion held by many of the ancients that our sensations are spread completely through our bodies, an opinion which we have been obliged to give up. The reasons for this change of view are several. First, it has become well known that, if a nerve distributed to a given area of skin is cut at some distance from that area, the spot, though unaffected in any direct way by the operation, will give rise to no further sensations even when it is severely stimulated. Hence it is clear that the sensations do not reside simply in the skin. But not only may pain thus be absent from a given area of skin; it may be present when the skin with which it is supposed to be associated is absent. Persons who by accident or otherwise have lost an arm or a leg often experience long after the loss vivid and intense sensations from definite parts of the missing member. So precise and sharp are these sensations and so certainly do they seem to be associated with the lost part that some of the less knowing of these unfortunates have attempted to exhume or otherwise get possession of the lost member in an endeavor to alleviate their unpleasant sensations. These misunderstandings, for such they are, can be swept away and the matter put in its true light when we recognize that our sensations are not located in the peripheral parts affected but in the central nervous system, and within that portion of it known as the cerebral cortex. As long as this organ is intact, sensations may arise, and, though these are usually due to nervous impulses from the sense organs, they may be called forth by an internal stimulus as well. Thus it is that a missing arm may be represented by sensations years after it has been severed from the body. With a loss of an appropriate part of the cerebral cortex, however, comes a loss of sensation that is absolute and final. From this there is no recovery. Our sensations then are not spread throughout our bodies, as was taught in ancient times but are limited strictly to the nervous system and in all probability to that part known as the cerebral cortex.

Not only are our sensations thus activities of the cortical part of the brain, but there is good reason for believing that our whole conscious life is similarly restricted. In the cerebral cortex lies memory with its wealth of stored experiences, in this organ love, hate and fear come into being; here

arise the cool deliberations of the man of science, the dreams and aspirations of the poet, the passion of the religious enthusiast, and, when abnormalities intervene, the ravings of the madman. Contrary to ancient belief, the spleen does not engender temper, nor do the affections flow from the heart. These and all other like attributes proceed from the brain. And yet the old traditions have so strong a hold upon us that I doubt whether any modern suitor would forward his cause by offering to the lady of his choice the real organ of his affection, his cerebral cortex, rather than his heart.

Accepting the modern view that the conscious life of man is not a function of his body as a whole but an activity limited strictly to his nervous system, it follows that the evolution of this system becomes a question of special interest. In man and the other higher animals this system consists of a most intricate collection of transmitting fibers, end-stations, centers and the like so disposed as to receive and record the influx of surrounding changes and to respond to these by appropriate movements. The light of a friendly countenance reaches us through the eye and a word of salutation through the ear and off comes the hat in response. When we scrutinize more closely the machinery of these operations, we find it simple in outline, though inconceivably intricate in detail. There are first of all the sense organs of the body, the eyes, ears, nose, mouth and so forth each attuned to a particular set of influences or stimuli and each delivering to the central organs evidences of the momentary states of these stimuli in the exterior. Next are the central organs, the brain, spinal cord and the like, parts that receive the flood of sensory information from the outer world and pass it on unnoticed or store some remnant of it as a part of life's experience. Last of all are the voluntary muscles set in action by impulses from the central apparatus and capable of performing the thousand acts good or ill that make us the responsible beings that we are. These in gross outline are the three great categories of our nervous machinery, or better, of our neuromuscular machinery, for muscles are necessarily an integral part of this chain. When such a chain goes into action, sense organ, central nervous organ and muscle, we speak of this as a reflex, for it resembles light in that it passes from an external source inward to a central organ whence it is reflected, so to speak, outward to the muscle.

If we examine the nervous systems of animals lower than man, we find in them the same three categories of parts. All the vertebrates from the mammals to the fishes have sense organs, central nervous organs and muscles. The same is true of the snails, the clams, the insects, the crabs and many others. Even the worms possess these three classes of organs, though with less differentiation as a rule than in the higher animals.

But, when we study the jelly fishes, the sea anemones, or hydroids, the case is different. Here we meet with an obvious simplification and what is noteworthy is that all three parts are not equally reduced, but that one, namely, the central organ, has suffered almost complete obliteration. In these lowly creatures the sense organs, either in the definite form of eye spots and the like, or as broad receptive surfaces without great specialization, are superimposed almost directly upon the more deeply seated muscles. Such animals often have not even a trace of an intervening nervous organ that could be called a central organ. The sense organs may thus connect directly with the muscles. Obviously under these circumstances the sense organs lack entirely that function that they showed in so marked a degree in the higher animal,

namely, the supply to the central organs of information, so to speak, as to environmental changes. In these more simplified conditions they must be restricted to the simple process of exciting the muscles to activity in consequence of special forms of sensory stimulation. They act, in other words, as a series of local triggers to set off muscular activity in various parts of the body as needed. Here then we see a stage in the evolution of the nervous system in which the sense organ and the muscle are the essential parts, but the central organ is to all intents and purposes omitted. Obviously, this stage must precede that in which central organs are present and these organs, brain, spinal cord and the like, must be looked upon as of later racial origin than sense organs and muscles. It may at first sight seem strange that so significant and all-important an organ as the brain should have been evolved secondarily in relation to sense organs, but such seems to be the case and we are justified, I believe, in stating that animals possess a brain in consequence of their having previously had sense organs; not that they possess sense organs because they have a brain.

The absence of a central organ and the presence merely of sense organs and muscles in sea anemones and other like forms makes itself felt in the activities of these animals. As I have already pointed out, that feature above all others that makes one of the higher animals, and especially man, a unit, is the possession of mental traits. Our conscious life affords our strongest claim to individuality. When this is disturbed, as in cases of double personality or in the various forms of insanity, even so practical a matter as the law takes cognizance and we treat such individuals differently from the common run of men. This unifying influence of the nervous system, technically spoken of as its integrative action, is almost completely absent from such animals as the jelly fish and sea anemones. With them individuality is a very subordinate character, and it is questionable whether they possess any trace whatever of that trait which we denominate personality in ourselves. They possess no single organ to which the nervous experience of their various parts may be referred to the advantage of the whole. Hence such nervous organization as they have is appropriately styled diffuse, in contrast with the centralized condition of higher forms.

The significance of this state of affairs is well seen in the activities of sea anemones. Many years ago it was shown that, if a single tentacle is snipped from the mouth region of a sea anemone and held in sea-water so that the observer can recall which side of the tentacle was originally turned toward the mouth of the animal, the tentacle will be found to entangle food and to twist itself in a direction that would be appropriate for the delivery of the food to the mouth were that aperture still in its original relation with the tentacle. This response, which has been repeatedly confirmed by others, including myself, shows that each tentacle contains within itself the necessary nerve and muscle to carry out its own movements, and that it is not dependent, as in the case of the arms, legs, jaws and so forth of the higher animals, upon a distantly located central nervous organ to initiate, control and subdue its movements. In a similar way I have recently shown that the pedal disc with which many sea anemones creep about will, in certain species, carry out perfectly normal locomotor movements even after the other half of the animal, including the mouth and tentacles has been cut away. This instance also demonstrates the neuromuscular adequacy of the part of the animal concerned and its relative independence of the rest. Auton

omy of parts, then, is one of the most striking aspects of the neuromuscular organization of the sea anemones and is strong evidence in favor of the absence of a centralized nervous organ in these animals. The same conclusion can be drawn from certain aspects of the feeding habits of sea anemones. If one of these animals is persistently but slowly fed by the tentacles on one side of its mouth, it will sooner or later cease to take food by these tentacles, though the muscles of the tentacles are in no sense fatigued. If food is now applied to the tentacles on the opposite side of the mouth, feeding will recommence almost as though the animal had not been fed previously. Thus the change of response induced on one side of the mouth has had little or no effect on the other, a condition referable to the absence of a central nervous organ. It is thus evident how different the organization and the responses of an animal without a central nervous organ are as compared with those of forms possessing such an organ.

Sense organs and muscles may therefore be regarded as two elements more primitive than the central nervous organs in the evolution of the neuromuscular mechanism. What is the source of these two parts? Did they arise together, twins at a single birth, or is one the older, and, if so, which? Kleinenberg in his theory of the neuromuscular cell, and the Hertwigs in their account of the nervous system of sea anemones, were both led to declare in favor of the simultaneous and dependent origin of nerve and muscle. Claus believed that these two elements arose independently and came together secondarily, a view subsequently espoused by Chun. When, however, animals more primitive than sea anemones, such, for instance, as sponges, are studied, a different solution to the problem from those just suggested is obtained. These lowly forms as mature animals possess no powers of locomotion whatever and the few movements that their bodies exhibit are carried out with the utmost deliberation and slowness. They can very slightly and always with great slowness bend and unbend their bodies as a whole, and they can close and open the numerous inlets and the few outlets by which the spaces within their substance are set into communication with the surrounding water. All these movements are carried out by a very simple form of muscular tissue and so far as concerns the study of their bodies, both anatomical and physiological, there is no evidence whatever of the presence of sense organs or other forms of nervous tissue. It therefore seems quite certain that in sponges we have primitive animals possessed of muscle but devoid of nerve even in the form of sense organs, and we may therefore conclude that, between muscle and sense organs, the muscle is of more ancient origin and marks the beginnings of that series of functionally related parts that culminates in the central nervous systems of the higher animals.

These views as to the steps in the evolution of the nervous system, as to the sources of our nervous structures and activities, have already found expression. They carry with them, however, certain implications concerning the manner in which we should frame our hypotheses as to the springs of nervous action, implications that have not been so generally appreciated. In the early part of this address I sketched the commonly accepted view of the organization of nerve and muscle in the higher animals. From the standpoint of human interests the sense organ is the avenue through which we gather in the course of our lives that enormous body of information concerning our surroundings. By smell, taste and touch we gain a knowledge of the more elemen-

tary chemical and physical aspects of the environment. Touch, moreover, gives us form and position and passes imperceptibly into that vague but enormously important sense, the muscle sense, through which the movements of our bodies, our limbs and other parts are checked and adjusted and the whole problem of spatial relations receives a new setting. Closely allied to these senses is the ear as an organ of equilibration responding to the pull of gravity and to our sudden changes in position and, like the muscle sense, affecting our conscious states so slightly that we scarcely know we have such a sense till on sea or on train excessive stimulation due to the unusual form of motion draws on characteristic discomforts. Next may be mentioned the ear as an organ of hearing attuned to the sounds of nature and in man attentive to the voice, that marvelous means of signaling whereby the momentary mental life of one human being can be quickly and accurately imposed upon another. And finally the eye with its responsiveness to light three thousand times greater than that of the most sensitive photographic plate, adjusted to color and to form, and in no whit behind the ear in its social significance. Thus our sense organs literally deluge us with a flood of messages concerning our surroundings and yield us all the elements out of which our mental life is built. In fact there is good reason to believe that without this sensory inrush consciousness itself could never come into being. The newborn brain is not unlike the western desert; only after irrigation in the form of sensory inflow does consciousness begin to blossom.

Considering the enormous significance of the sense organs for man as the means of supplying him with the content of his mind, it is not surprising that in attacking the problem of the brain and our mental states students should have made their approach almost entirely from the sensory side. The quality and quantity of sensations were exhaustively investigated and even the central nervous organs were dealt with from the standpoint of their sensory relations. In brief, the sensation became more and more the established unit in considering nervous action, and we were led to interpret the nervous states of the whole range of lower animals by the sense organs they were shown to possess. If a particular worm or jelly fish had an unusually developed eye, it was assumed that the given animal enjoyed an excess of sensation akin to sight with us as compared with its less fortunate neighbors. If a crawfish inhabiting caves possessed degenerate eyes, but was covered with enormously developed tactile hairs, it was supposed to have realized something of that excessive development of touch which we know is characteristic of the human blind. Thus the well-known relations of our sense organs to our mental life gave a basis for the assumption of corresponding mental states in the lower animals.

If, however, the sources of our nervous organs are such as I have sketched, it is extremely doubtful whether the interpretations just mentioned are at all justifiable. In the beginning sense organs had nothing whatever to do with the delivery of messages to a conscious center. They were organs concerned merely with the calling forth of muscular movements. The animal with especially developed eyes or with unusual organs of touch is not necessarily endowed with special sensations in these directions; it may be an animal merely adapted to respond with unusual delicacy to light or touch and without central nervous relations at all. Thus the sense organs in the lower animals come to have a very different significance from that formerly attributed to them. They are special means

of exciting action rather than organs of an informing nature. It must also not be forgotten that though the sense organs of the higher animals are in many cases primarily organs of information, so to speak, they probably all still retain their original function of exciting muscles, at least indirectly, to action. They are the beginnings of practically all reflex arcs. Not only is this true, but not a few of them retain, so far as our conscious life is concerned, much of that hidden and submerged state that characterizes them in the lower animals. They lie in their activities below the conscious and even the subconscious level. This can be exemplified in one of the senses already named, the muscle sense. We are almost continuously cognizant of light, noise, smell and so forth, but we find it almost impossible to realize in our conscious states sensations from the muscle sense. Obscure, vague and indefinite, they impress us scarcely at all. Only here and there do they appear to rise into the region of strong sensation. Within the last few years it has been shown that the sensation of hunger is dependent upon stomach movements. Each hunger pang is due to a wave of muscular contraction passing over the walls of the stomach. It is, therefore, not improbable that the hunger pang is a muscle sensation that, from its organic importance, has lifted itself from the low level of unconscious activity into the higher strata of our conscious states.

The great majority of the sense organs of the lower animals are concerned with yielding impulses to motion that are in no way associated with consciousness, and this is undoubtedly their primitive function. Such animals often exhibit complicated systems of transmission tracts connecting their sense organs with their muscles, and these tracts collectively mark the beginning of a central nervous system. It is probable that a sensory equipment of this kind, with the well-established beginnings of a central apparatus, afforded the necessary settings for the appearance of consciousness, which thus found roughed out by the earlier necessities of the organism a system of sensory and central components capable of sustaining future growth. At this stage the sense organ must have added to its primitive function of calling forth muscle activity that of supplying messages to a growing central organ, a function that has become of such paramount importance in man.

If this outline of the sources of our nervous activity is true, it follows that any conception of the nervous system that assumes sensation as a basal phenomenon is most assuredly to be abandoned. Sensations are associated with only the later phases of nervous development. The feature that has been present throughout the whole period of this evolution is muscular activity. In fact, as I have already stated, we have reason to believe that muscular activity preceded nervous origins and that nervous tissue appeared in consequence of the presence of muscles. Our own sensations, then, are not our most fundamental and primitive nervous processes, but behind these and of much more ancient lineage are our impulses to action, our wishes, our desires, and the whole vague body of nervous states that drive us to do things. These are the most ancient and deeply seated of our nervous propensities, and immeasurably antedate in point of origin, our sensations with all that supergrowth that constitutes the fabric of our mental life. We do well to warn ourselves to think before we act. Action is the oldest and most ingrained of our nervous functions, thinking the newest.

You will pardon me if I have led you from the realm of simple fact and observation far afield into that of pure speculation, for the general scheme of the sources of our nervous action that I have outlined must be

regarded as largely speculative. Such outlines are, however, suggestive of the myriads of questions that science attempts to answer. And the answers, when found, are the means of correcting these outlines that they may coincide more nearly with the truth. It is to the attainment of this general truth that establishments such as the Scripps Institution are dedicated. May the increased facilities that we celebrate to-day yield an ample and worthy return.

G. H. PARKER

HARVARD UNIVERSITY

A SHORT ADDRESS TO THE GRADUATING CLASS OF THE HARVARD MEDICAL SCHOOL, 1917

IT is on occasions such as this, at certain eras in the lives of young men, that we compel them to listen to words of counsel, however this ultimate end of giving counsel may be concealed in verbiage. Older men, in which class I have been rather reluctantly compelled to put myself, are generally selected to give utterance to these words, from the fact that, having had a wider experience, their views will have a greater importance, and indeed many of them and even their hearers really believe this. It must be said that there is no demand for this on your part and these addresses, like lectures, are forced upon you; at least I do not think you would rise up and clamor for them, but you passively submit.

If one looks over the literature of addresses—and the sum of the published ones would almost fill the Alexandrian Library—there is great similarity in the matter and in the form of presentation. In recent years there has been some decline in attempts at eloquence and you are no longer told that medicine is a useful and noble profession, with citation of examples, or that you are a vessel embarking on the sea of life, this associated with descriptions of lighthouses, cross currents, storms, etc. I speak feelingly, for on looking over some old addresses of mine I found that I also had once spoken of ships and storms and lighthouses, and I should like to humbly apologize to my former auditors.

This desire of ours to talk is partly due to the garrulousness of age, which is compelled to substitute words for action, and having found how much easier the process is, and how pleasant, indulges itself in the vice; and partly to the persistence of an utterly mistaken view of education. The idea that education, that process which aims at the development of the individual with the view that he shall be capable of greater service and of greater individual happiness, can be attained by telling the aspiring student things or having him study merely the product that others have wrought, has unfortunately not entirely passed. If I have learned anything in my now somewhat long life as a teacher it is that the process of education consists in giving the student opportunity, the material to study, be it mankind, books, ants or dead bodies, and in every way assisting him in the study, always recollecting that the result must be individual, the product of the material which his brain has received, digested and assimilated. We must not think that we can give him in words merely the conceptions which we have arrived at, although he may derive some profit by comparing our concepts with his own.

We should not think that in an address we can give a young man any thing of real value. What we are depends upon the individuality of our living material and the result of the action upon this of the special matter which education gives plus the more generalized influences of the environment. It is particularly now, when such enormous changes in environmental conditions, as compared with those under which

we have lived, exist and are in process of creation, that the futility of attempts to force our views upon you must be apparent. As I see the great struggle now it is not only between democracy and imperialism, but underlying this a still greater struggle between socialism and individualism. This is apparent in medicine as it is in every other domain of life and what will be the outcome no man can say. The currents in the sea are so vast in extent and power, the winds so variable, that there is the temptation to merely stand aloof and be swept along. I think I can advise you, reluctant as I am to attempt advice, to resist this; plunge in and struggle for what seems to you the right, remembering that general conditions of social environment depend upon the actions of individuals and it is you who are the creative force—on you rests the responsibility.

With this as a preamble it would give me great pleasure to pursue the subject further, for I really like to talk, and as I look around and see you I recall many happy hours which are associated with you and I am grateful to you for having given me this happiness. But fortunately for us all time passes, changes, it is now gone, and I have been spared the chance of giving you opinions which are probably erroneous and possibly productive of injury.

I think, however, it is only right that I should tell you that addresses may have a great importance and even determine future events, as the following example shows. Some time ago I happened to be in the capital of a Brazilian state just after a gubernatorial election. There had been the usual phenomena which such an event in a Brazilian city produces. Some fifty people killed, three times as many wounded, a newspaper office blown up and on numerous houses the peculiar pits made by the modern jacketed bullet. At the time I reached there, two weeks after the inauguration, everything was going on as usual. It seems that full arrangements were made to blow up the governor on his way home after the inaugural address. But the importance of the address had not been properly considered. The governor spoke long, giving the history of the country from its discovery, the modern conditions and the hopes of the future. The matter was dull, hours which seemed like weeks and minutes which seemed like days passed and he continued to speak without the audience being able to see any hope of cessation. The conspirators were nervous, the exciting events had deprived many of them of their wonted calm siestas, and under the soothing influence of the orator many slept; others were not able to endure the absence of alcohol for so long a period and these departed to look for it; for others so long a period of silence on their part could not be endured and these departed to gather up an audience; others felt they might be missed at home and these sought the presence of the household gods. In short the conspiracy was broken up, the audience gradually departed with the taxis which were to have formed the procession, and the governor was finally left speaking to a single close friend who went home with him by a back way, and the country for a time was saved. The party newspapers which printed the speech said it was a masterly effort; the opposition was silent, for their newspaper had been blown up.

W. T. Councilman

Harvard University

SOME SUGGESTIONS FOR NATIONAL SERVICE ON THE PART OF ZOOLOGISTS AND ZOOLOGICAL LABORATORIES

In an article in the *New Republic* for March 31 last entitled "America Prepares" William Hard pokes fun at the enthusiasm for organization which has taken possession of the coun-

try; the National Research Council receives its share of serio-comic attention and as a climax of the ridiculous and absurd there is mentioned the Committee on Zoology and Animal Morphology. "I doubt," he says, "if any other nation ever responded to the prospect of war with a scheme of national defense which included a Committee on Zoology and Animal Morphology."

It should not be forgotten that the establishment of the National Research Council antedated the declaration of war by a whole year and that one of its chief functions was and is the promotion of research in all branches of science in the belief that human progress depends upon increasing knowledge of nature and that national welfare can be advanced most effectively by the cooperation of scientific investigators.

With the country at war it is but natural that the activities of the Research Council should be directed primarily to problems connected with the war and patriotic men and women in all branches of science, as well as in every other occupation, are asking how they may best serve the nation in this crisis. Zoologists, no less than others, are asking this question and it is with a view to answering it in a general way that the Committee on Zoology of the National Research Council has drawn up the following suggestions.

To the zoologists no less than to the *New Republic* it is evident that this science is only indirectly and remotely related to war—indeed it has been claimed that hitherto the biological sciences are the only ones which have not been used for the destruction of human life. The greatest national service which the biological sciences can render in war as well as in peace is in conserving human life, and also in protecting and improving useful animals and plants and in controlling or destroying injurious ones; when it is remembered that practically everything which we eat or wear comes from animals or plants it will be realized that this is no slight service.

Many of the practical and economic branches of biology have long been well organized for such service and this applies particularly to medicine, sanitation and agriculture, but in each and all of these branches the trained zoologist may render valuable aid. Probably no other scientific men are better prepared by training and no other institutions better fitted by equipment to assist in medical and sanitary work than are zoologists and zoological laboratories, and in the matter of the propagation and improvement of useful animals and the destruction of useless or injurious ones the zoologist should be especially at home. In many instances zoologists who have hitherto confined their attention to theoretical and general problems would need to turn their attention to new lines of work, but it can not be doubted that practise in solving general and theoretical problems would be of great value in dealing with specific and practical ones.

I. SANITARY WORK

1. Much sanitary work is primarily zoological as, for instance, the study of the life histories of parasitic protozoa, tapeworms, flukes, roundworms, insects, mites, etc., together with methods of their control or eradication.

2. The elimination or control of animal carriers of disease-germs, such as flies, mosquitoes, bugs, fleas, lice, rats, etc.

3. Assistance in medical diagnosis, as in the microscopical or chemical examination of blood, urine, feces, sputum, etc.

4. Microscopical or chemical examination of water and soil of camp sites, drainage areas of cities, etc.

5. The zoological aspects of the collection and disposal of garbage and sewage.

In view of the importance of zoological science in dealing with old and new problems which will arise in connection with sanitation it would be very desirable to have at least one trained zoologist connected with the medical staff of each mobilization camp.

II. AGRICULTURAL WORK

1. Cooperation with the agricultural agencies of the states and nation in the elimination of animals which prey upon or are parasitic upon domestic animals; of animal pests destructive to crops, fruits, forests, to stored vegetables, grain and other food supplies, to

clothing, woodwork and other manufactured products.

2. Application of principles of heredity to the improvement of breeds of domestic animals.

3. Study of physiology of reproduction with a view to increasing productivity in animal breeding; for example, improved methods of incubation, brooding and rearing of fowls.

4. Determination of standards of feeding and nurture of domestic animals for best general or specific results and for greater economy.

III. EXTENSION OF FOOD SUPPLY

1. Preservation, propagation and domestication of useful wild animals. Probably certain useful birds and mammals, now wild, might be domesticated; others not native might be imported under proper precautions.

2. The protection of birds which are beneficial to agriculture. It is estimated that in Kansas alone the annual preventable damage to food crops amounts to thirty million dollars. The largest natural elements in the prevention of this loss are ground-nesting birds. Migratory birds should be protected by the passage of the House of Representatives Bill No. 2612, known as the "Migratory Bird Treaty Act."

3. Exploitation and propagation of useful marine and fresh-water animals, in cooperation with the Bureau of Fisheries. There is an unlimited supply of food in the oceans of the world and we have scarcely begun to reap the "harvest of the seas." Countless forms of fishes, crustacea, mollusks and other types which are not now generally used as food are both wholesome and delicious when properly prepared. The Commissioner of Fisheries says:

> Zoologists may perform a service by bringing to the attention of people, in the course of their conversations, lectures, etc., the reasons for looking to the fisheries for increased food supply, the wholesome character of the meat, the economy with which fish are produced without dependence upon agriculture for their food. Many new fishes are being introduced into the market—sharks, bowfin, burbot, sable-fish and others, and it is certain that zoologists can do a good service in helping to overcome popular inertia that will be encountered. The Bureau will gladly send circulars announcing new fishes to any who apply.
>
> The biological problems of fish ponds are numerous. Recently a college zoologist in association with the Bureau began giving special attention to the relation of dragon flies and damsel flies to fish culture in ponds. Already he has gained results that were unexpected, but that are highly significant. The larvæ of dragon flies were known to prey upon fish fry, but this investigator, Professor C. B. Wilson, finds that they also prey in greater measure upon other insects that are more effective enemies of fish fry; various other interesting interrelations are discovered This is only an illustration of what may be done with various groups of aquatic and semi-aquatic animals and plants. Results of value may, in some cases, be obtainable in a brief space of time.
>
> We know very little about the parasites of fishes, their relative abundance under different conditions of environment, their life-histories and alternate hosts. Means of control can not be devised without more complete knowledge regarding particular species.
>
> We should be glad to advise either directly or through you with any zoologist who is considering a particular problem related to the fisheries.

IV. EDUCATIONAL AND SOCIAL WORK

1. Thorough studies of human heredity as a necessary preliminary to any attempt to permanently improve our human stock and increase national efficiency.

2. The teaching of zoology, as well as of other sciences, may be made a very important means of promoting national intelligence, cooperation and welfare.

3. While the great demands on medical men last, zoologists would be well qualified to assist in medical education, especially in histology, embryology and neurology.

4. The prosecution of research work, whether in pure or applied science, is a national duty of the first magnitude; the continuance of research work by zoologists, and especially work already begun which can not be interrupted without serious loss to science, is a real national service.

V. MISCELLANEOUS PROBLEMS

In addition to these general lines of work the following special problems have been suggested:

1. The microscopical inspection of food, clothing and supplies.

2. Studies of the coat coverings of animals with a view to the utilization of nature's principles in making the clothing of soldiers light, warm, well ventilated, impervious to water and protectively colored.

3. Studies of the mechanism of aquatic and aërial locomotion in animals with reference to its application to submarines and aëroplanes.

4. Utilization of gulls and other aquatic birds in locating submarines.

5. Studies of the mechanisms of limbs and joints with a view to offering suggestions in the construction of artificial limbs.

6. Investigations in tissue cultures, grafting and regeneration, with a view to their surgical applications.

The committee would welcome any further suggestions either in the line of additional problems or of practical methods of attacking those named.

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Princeton University,
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G. H. Parker,
Harvard University,
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University of Michigan,
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U. S. Commissioner of Fisheries,
Committee on Zoology of the National Research Council

SCIENTIFIC EVENTS

SUSPENSION OF THE KEW BULLETIN

Publication of the *Kew Bulletin* has been suspended on the ground of shortage of paper. In regard to this *Nature* remarks:

When we see the waste of paper used in Parliamentary Reports, National Service propaganda, and by government departments generally, and place this by the side of the amount required for the continued publication of such a periodical as the *Kew Bulletin*—imperial in its scope and influence—we begin to despair that our state officials will ever possess true standards of value in matters pertaining to science. The subject is dealt with in an article on another page; and all we wish to say here is that we are glad to accord the hospitality of our columns to a contribution intended for the *Kew Bulletin,* and that we earnestly hope action will be taken to secure the continuance of a publication which is more essential now than ever it was.

The article mentioned says:

It must be remembered that Kew is the central institution of a great system of smaller institutes established in every region of the empire, and that these institutes exist to further the material prosperity of the countries in which they are situated. The principal sources of wealth in most of our foreign possessions consist for the most part of vegetable products, and it is difficult to overrate the importance of keeping the botanical stations, remote as they mostly are from the main channels of current scientific work, continually informed on relevant matters which from time to time reach the great clearing-house at Kew. It must be evident to everyone that any action which tends to lower the efficiency of these institutes of economic botany must operate in a manner detrimental to the material interests of the country or countries thus affected. It is difficult to believe that either the India Office or the Colonial Office, which are both concerned with the functions that only Kew is in a position effectively to discharge, can have been consulted in the matter, or, if they had been so consulted, that they could have approved of a step so unsound alike on economic and financial grounds.

Furthermore, it should not be forgotten that Kew receives a good deal from other countries by way of exchange for the *Bulletin,* which it is now proposed to suspend. We understand that enemy countries, although their colonial interests are as nothing compared with our own, have, nevertheless, not seen fit to interfere with the continued publication of their own corresponding journals.

In fact, the same official lack of appreciation of the importance of scientific inquiry and research which was a matter of common knowledge amongst our competitors before the war still continues to sap the foundations of our recognized claims to our foreign possessions, which should largely rest

on the encouragement of their material development on sound economic, and therefore on scientific, lines.

It is earnestly to be hoped that the action apparently taken may be reconsidered before we allow ourselves, as a colonial power, to be made ridiculous, and as a business people to stand committed to the policy of penny wise and pound foolish.

Unless we learn in time the lessons which this war is enforcing on every side, namely, that the way of prosperity in the future lies in promoting scientific knowledge and in utilizing the results of scientific investigation, it will make but little difference in the long run whether we win the war or not. For we should assuredly lose in the far more serious conflict that is certain to follow it, a conflict in which the claim for superiority will be inexorably decided against any nation which refuses to take full advantage of that knowledge which is power in a sense far more real than ever before.

DAYLIGHT SAVING

RESOLUTIONS in reference to daylight saving were, on May 23, adopted by the American Philosophical Society as follows:

Resolved, That The American Philosophical Society, convened in special meeting for this purpose, memorialize the Congress of the United States urging the early enactment of the identical bills, House No. 2609 and Senate No. 1854, entitled respectively "A bill to save daylight and to provide standard time for the United States."

Resolved, That the members of the American Philosophical Society urge their respective senators and representatives to take early and affirmative action on these bills, and that the society address the President, asking his approval of them.

Resolved, That the members of the American Philosophical Society urge their respective state legislatures to pass resolutions favoring these bills, as the Pennsylvania Legislature has recently done, and that they further urge commercial, financial, agricultural and engineering societies in their respective localities to memorialize Congress for the early enactment of these bills.

Mr. Arthur H. Lea, in moving the adoption of the above resolutions, said in part:

In his *Autobiography,* Benjamin Franklin wrote: "In walking through the Strand and Fleet Street one morning at seven o'clock I observed there was not one shop open, though it had been daylight and the sun up above three hours; the inhabitants of London chusing voluntarily to live much by candle light, and sleep by sunlight, and yet often complain, a little absurdly, of the duty on candles and the high price of tallow." (Bigelow edition, Philadelphia, 1868, pp. 291–92.)

The founder of this society was the first to present the idea of Daylight Saving, but his suggestion has been neglected for one hundred and fifty years. Men can not and will not individually alter their habits of rising and going to bed, but collectively they can do so wth no inconvenience. Traveling eastward or westward we alter our watches one hour at certain places and immediately forget the change and adapt ourselves to the new time. By federal legislation we can do the same and as easily throughout the entire country.

The bills aforesaid would legally establish the standard time zones adopted by the railroads in 1883, which innovation was then recognized as an immense convenience. They would also cover any legal questions by providing that standard time is to govern common carriers, government officers and persons subject to the jurisdiction of the United States, in their acts and legal relations, rights and contracts. Furthermore, after establishing standard time, these bill provide for advancing it in five zones, respectively, by one hour at 2 A.M. on the last Sunday in April of each year, and for retarding it by one hour at 2 A.M. on the last Sunday in September. The only amendment necessary, now that April, 1917, is past, is to provide that for this year the advancement shall take effect at the earliest date, to be specified, after approval of the Act of Congress.

All the belligerent European nations, except Russia, have adopted Daylight Saving as a war measure for efficiency and economy, and adjacent neutral nations, such as Norway, Sweden, Denmark and Holland, have done likewise. These European nations now follow time standards 6 and 7 hours ahead of ours, and therefore their business day is practically over before ours begins. Stock exchanges in London and Paris now close one hour before our Exchanges open, and the Continental European stock exchanges close two hours before our opening. Stock exchange transactions within the same day would be facilitated by our advancing our time, and the same would be true of ordinary commercial and financial transactions across the ocean.

THE SMITHSONIAN STATION FOR THE STUDY OF SOLAR RADIATION

The Smithsonian Institution has established a station for the study of solar radiation on Hump Mountain, two miles from the town of Elk Park, North Carolina, at an altitude of about 4,800 feet. Dr. Charles E. Abbot, who has just returned from Hump Mountain, reports that the main and auxiliary buildings are ready and that the equipment is nearly all hauled up to the station. With the assistance of Mr. A. F. Moore, of Los Angeles, who is to be the local director, Dr. Abbot unpacked and set up most of the observing apparatus, all of which he expects will be ready for use in a few days.

Assisting Mr. Moore, is Mr. Leonard H. Abbot, of Worcester, Mass., and associated with Mr. Moore for some weeks will be Mr. L. B. Aldrich, of the Astrophysical Observatory, who left Washington recently for North Carolina to represent Dr. Abbot. The expedition is expected to continue at Hump Mountain for a year, or longer if conditions warrant. Its purpose is to observe variations of the sun's output of radiation, such as have been discovered by the Smithsonian Astrophysical Observatory and recorded heretofore at its station located on Mount Wilson, in California. It is hoped that the cooperative measurements of the new Smithsonian station in North Carolina and the station on Mount Wilson will promote weather forecasting.

The data needed for such forecasting is secured from measurements of the sun's variation made with the bolometer, invented by Dr. Samuel P. Langley, late secretary of the Smithsonian Institution, taken at observing stations located in different parts of the world. After comparing and correcting these readings registered by the sun's rays, they are referred to standardized tables and the corresponding changes in the temperature of the earth's surface calculated in advance for different localities.

In a pamphlet on this subject recently published by the Smithsonian Institution, the author, Dr. H. Helm Clayton, of the Argentine Meteorological Service, states:

Two important conclusions are derived from this study: (1) That there is an intimate relation between solar changes and meteorological changes of short period, and that measurements of solar radiation like those made by Dr. Abbot and his associates have the greatest importance for meteorology. (2) That there is a class of meteorological changes which have their origin in equatorial regions and by a transference of air, probably in the upper layers, are felt within a few days in higher latitudes. These changes are the complement of the complex meteorological drift which goes from west to east in temperate latitudes with a component of motion from pole to equator in both hemispheres.

THE AQUARIUM OF THE CALIFORNIA ACADEMY OF SCIENCES

By the will of Mr. Ignatz Steinhart, recently deceased, the California Academy of Sciences will receive the sum of $250,000 for an aquarium building to be erected in Golden Gate Park adjacent to or adjoining the buildings or museum of the Academy of Sciences. According to the terms of the will the aquarium is to be known as the Steinhart Aquarium, to be under the management, superintendence and control of the California Academy of Sciences, and the expense of maintenance to be met by the city of San Francisco.

At a recent election a charter amendment was adopted which directs the Board of Supervisors of the city of San Francisco to include each year in their annual budget an item of *not less* than $20,000 for aquarium maintenance.

Mr. Steinhart made many bequests to charitable and educational institutions, the total amount disposed of being about $3,000,000.

SCIENTIFIC NOTES AND NEWS

Among the degrees conferred at the commencement at Princeton University were the doctorate of laws on Dr. George E. Hale, chairman of the National Research Council, and the degree of doctor of science on Dr. Charles H. Mayo, retiring president of the American Medical Association, and Theobald Smith, director of the department of animal pathology of the Rockefeller Institute for Medical Research.

THE degree of Sc.D has been conferred by Union College on William Pitt Mason, professor of chemistry in the Rensselaer Polytechnic Institute.

MR. ORVILLE WRIGHT was awarded the honorary degree of doctor of science at the graduation exercises of the University of Cincinnati.

LEHIGH UNIVERSITY has conferred its doctorate of laws on Wallace C. Reddick, president of the North Carolina College of Agriculture, who gave the commencement address.

AT the formal opening of the American Red Cross Hospital of Paris, on May 31, President Poincaré, bestowed the cross of the Legion of Honor on Dr. Joseph A. Blake, surgeon-in-chief of the hospital, and thanked him in the name of the republic for his valuable services during the war.

PROFESSOR HALLER has been elected honorary president of the newly organized French Society of Industrial Chemistry.

GEORGE B. WISLOCKI has been appointed to take charge of the laboratory of surgical research in the Harvard Medical School.

THE California State Board of Health has appointed Professor Charles A. Kofoid, professor of zoology, University of California, as consulting biologist, and Assistant Professor W. W. Cort, associate biologist, and has made provision for the establishment of a biological laboratory for protozoological and helminthological work in conjunction with their Bureau of Communicable Diseases. Two assistants will be appointed in the laboratory.

THE board of trustees of the Leo M. Levi Memorial Hospital, Hot Springs, Ark., announces the founding of a department of medical research to be maintained in connection with the hospital. Dr. Geo. L. Hoffman, formerly assistant to Professor W. Kolle, past director of the Institut zur Erforschung der Infektionskrankheiten in Bern, has been appointed director of the newly founded department, and will assume charge on July first.

MR. PAGE, the United States Ambassador, attended the recent annual meeting of the Royal Geographical Society of Great Britain and presented to Mr. G. G. Chisholm the medal awarded to him by the American Geographical Society. Mr. Chisholm is lecturer in geography at the University of Edinburgh, secretary of the Royal Scottish Geographical Society, and author of commercial and school geographies. Mr. Page, in handing the medal to him, said he had richly earned the recognition of his countrymen for the painstaking character and conscientious thoroughness of his work. Mr. Douglas W. Freshfield, the president, presented the Royal medals and other awards that have already been announced in SCIENCE.

AS reported in last week's SCIENCE, Dr. Arthur Dean Bevan, of Chicago, was elected president at the recent meeting of the New York Medical Association. The following officers were also elected: *First Vice-president,* Dr. Edward H. Bradford, of Boston; *Second Vice-president,* Dr. John McMullin, U. S. Public Health Service; *Third Vice-president,* Dr. Lawrence Litchfield, of Pittsburgh; *Secretary,* Dr. Alexander C. Craig, of Chicago; *Treasurer,* Dr. William Allen Pusey, of Chicago; *Chairman of the House of Delegates,* Dr. Hubert Work, of Pueblo, Colo.; *Vice-chairman,* Dr. Dwight H. Murray, of Syracuse, N. Y.; *Trustees,* Dr. Philip Marvel, of Atlantic City; Dr. W. T. Sarles, of Sparta, Wis.; Dr. Bert Ellis, of California, and Dr. Wendell C. Phillips, of New York City. Chicago has been chosen as the place of meeting for 1918.

THE faculty of the Agricultural and Mechanical College of Texas recently appointed a committee on National Defense to cooperate with the Council of National Defense and the State Council on National Defense, consisting of the following members: Dr. W. B. Bizzell, *chairman;* Colonel Clarence Ousley, Mr. H. M. Eliot, Dr. Charles Puryear, Dr. O. M. Ball, Mr. B. Youngblood, Dr. E. P. Humbert.

J. E. TODD, formerly professor of geology in the University of South Dakota and for the last ten years occupying a similar position in Kansas University, has recently been retired on half pay. He hopes to continue research

work, including a report on the history of Kansas during the Glacial Period, which is nearly ready for publication by the Kansas University Geological Survey. He celebrates this year the fiftieth anniversary of his graduation at Oberlin College, O.

IT was incorrectly stated in the issue of SCIENCE of June 8 that Dr. George Dock, of St. Louis, had received the French war cross for service in France. The item, which in some way became distorted in the daily and medical press, should have referred to Dr. Dock's son, George Dock, Jr., a Dartmouth graduate of 1916, who has been in the American Ambulance for more than a year and was for many months in the vicinity of Verdun. There, in the words of the citation, "s'est distingué . . . par son mépris du danger et son entrain remarquable. Les 18 Septembre et 28 Decembre, 1916, s'est depensé pour des evacuations difficiles et particulièrement pénibles sur des routes sans cesse bombardées."

DR. ALEXANDER LAMBERT, of New York, has been ordered to France as medical adviser to the War Relief Commission of the Red Cross during the war. Dr. Tom A. Williams, of Washington, goes to France at the end of this month to fill an appointment as neurologist in the French Service de Santé.

MR. GEORGE P. ENGELHARDT, curator of invertebrates, and Mr. Jacob Doll, curator of Lepidoptera in the Brooklyn Museum, have undertaken an expedition to the plateau regions of southwestern Utah and northern Arizona. The objects of the field work will be general, though particular attention will be given to lepidoptera, small mammals and reptiles. The expedition was made possible through the generosity of Mr. B. Preston Clark, of Boston.

THE University of Pennsylvania Museum Expedition to study the Eskimos of Bering Straits and of the northern coast of Alaska, has left Seattle, Wash. It is financed by John Wanamaker and headed by Lieutenant Van Valin, who for three years was in the government service as an inspector of schools in Alaska.

AT the annual meeting of the Botanical Society of Pennsylvania held on the grounds of Mr. Robert Le Boutillier, Wayne, Pa., on Saturday, May 5, 1917, Dr. C. Stuart Gager gave an address on "The aims and objects of the Brooklyn Botanic Garden."

THE annual congress of the Southeastern Union of Scientific Societies was held in London, in the rooms of the Linnean Society, on June 6–9. Dr. William Martin, formerly general secretary of the union, the president, had as the subject of his address "The application of scientific method."

THE eighth Halley lecture was delivered at the University of Oxford, on June 12, by Professor Arthur Schuster. The subject was "Terrestrial magnetism: past, present and future."

SIR ALEXANDER R. BINNIE, the distinguished English civil engineer, died on May 18, at seventy-eight years of age.

M. JOSEPH RIBAN, honorary professor of the faculty of sciences of Paris, known for work on organic and applied chemistry, has died at the age of eighty years.

WE learn from the London *Times* that it has been decided to take over a part, at least, of the Victoria and Albert Museum for the accommodation of the Board of Education and their staff. The Imperial Institute, which had been selected for this purpose, is to be devoted to other uses. The Trench Warfare Department, which occupied part of the Board of Education's premises in Whitehall, is to find a place in the building in Millbank of the British-American Tobacco Company, who, upon being informed of the needs of the government, immediately offered to surrender their headquarters on the understanding that other premises should be found for their staff. Arrangements are being made with an hotel to supply the necessary accommodation.

THE National Museum has recently received as a gift from Mrs. George W. Vanderbilt the botanical specimens and books of the Biltmore Herbarium, the well-known botanical institution established and maintained for many years by the late George W. Vanderbilt

at Biltmore, North Carolina. During the disastrous floods of last July the Herbarium was largely inundated, suffering a loss of about three fourths of the botanical specimens and injuries to a considerable portion of the library. The uninjured specimens, chiefly phanerogams, number about 25,000, and will be of great value to the National Herbarium in augmenting its representation of southeastern plants. The collection contains, also, a large series of *Cratægus* specimens, including the types of many species described by Mr. C. D. Beadle, curator of the herbarium and an authority in this difficult genus. The library includes complete sets of several important botanical and horticultural publications, as well as many botanical works not hitherto in the National Museum.

UNIVERSITY AND EDUCATIONAL NEWS

A COMMITTEE of the Massachusetts Medical Society, consisting of Samuel B. Woodward, chairman, Dr. E. H. Bradford, Dr. Edward C. Streeter, Dr. Arthur N. Broughton, Dr. Peer P. Johnson and Dr. Philemon E. Truesdale, has been appointed to further the establishment of a department of military medicine, surgery and hygiene, in the Harvard Medical School. It is proposed to raise an endowment fund of $100,000.

THE financial board of the University of Cambridge has issued a report on the estimated income and expenditure for the year 1917. Although the common university fund, which is derived from assessments of colleges, is slightly greater than in 1913, the university chest, which is largely derived from capitation fees, examination fees, etc., has fallen from £53,400 to £23,900. The board estimates that the normal expenditure on the university chest will be £36,200, as against an estimated income of £20,400, leaving a deficiency of £15,800. Towards this they are able to provide the sum of £12,700, leaving a deficiency of £3,100.

THE archeological and ethnological collections of the late Dr. J. William White, of Philadelphia, have been presented to the University Museum by Mrs. White.

AT the University of Virginia Dr. Theodore Hough, acting dean, has been made dean of the medical school; Dr. James A. Wardell, associate professor, has been appointed professor of pharmacology and materia medica, and Dr. John H. Neff, instructor, adjunct professor of genito urinary surgery.

AT Harvard University Earnest A. Hooton has been appointed instructor in anthropology, Clarence E. Kelley and Harlan T. Stetson, instructors in astronomy, William E. Brown, instructor in public health administration, Raymond E. Merwin, associate in Central American archeology, and Willis A. Boughton, assistant director in the chemical laboratory.

ASSOCIATE PROFESSOR W. M. CARRUTH, of the department of mathematics at Hamilton College, has been promoted to a professorship.

DISCUSSION AND CORRESPONDENCE

AN INSTITUTE FOR THE HISTORY OF SCIENCE

TO THE EDITOR OF SCIENCE: Referring to the proposal of an institute for the history of science and civilization, as outlined in a recent issue of SCIENCE,[1] the attention of all interested in this project is invited to the fact that the resources of precisely such an institution as has been proposed are indispensable to the full performance of its duties by the United States Patent Office, and to the fact that the resources of this office, inadequate as they now are, should in turn be at the disposal of the proposed institute, for the attainment of its separate purposes.

The suggestion is accordingly made that to the published list of important possible activities, there might most advantageously be added a sixth—the facilitation of prompt and reliable judgments upon all questions of novelty arising in connection with the administration of the patent laws, thereby aiding in the placing of the administration of such laws upon a secure scientific foundation. Surely the attainment of this additional purpose would be of sufficient public importance to deserve separate enumeration, and the furtherance of it

[1] SCIENCE, No. 1160, p. 284.

would constitute a most persuasive argument for the location of the new institute in Washington—within reach also of the Smithsonian Institution, the Bureau of Standards, the Bureau of Mines, the Department of Agriculture, the Geological Survey, the Medical Museum, the Carnegie Institution and the Library of Congress.

If any combination of circumstances can lead to united practical efforts toward common or related purposes on the part of those who seek a perfecting of the patent system, and those whose interests as scientists and educators extend beyond all current technical applications, it would seem past doubting that notable results must follow promptly.

In this connection attention is invited to the fact that the Patent Office is now admittedly unable to make an adequate application even of its present resources. The point here made is not that a surplus from the collection of fees is required to be turned over to the federal treasury, while the needs of the office for literature, laboratories, and men remain unprovided for. It is that the accumulation of patent grants has reached to such limits (about one and one quarter million grants), that, in the absence of adequate appropriations for the work of reclassification, the office is *unable to find the needles in its own haystack.* To quote from the current report of the Commissioner of Patents, Thomas Ewing:

> In 1890 there were 189 members of the examining corps, of whom 30 were examiners. The assistant examiners (who make the searches) numbered 159. Each assistant had to report on 251 applications per year.
>
> In 1916 the corps numbered 367, of whom 43 were examiners and 324 assistant examiners. Each assistant must report on 210 applications per year.
>
> The extent of the field of search is fairly represented by the United States patents granted and the available foreign patents. In 1890 there were 443,000 United States patents and 635,000 available foreign patents, making a total of 1,078,000. At the close of 1916 there were more than 1,210,000 United States patents and 1,690,000 available foreign patents, totaling 2,900,000.
>
> From these figures it will appear that the number of applications to be passed upon by each assistant has been reduced since 1890 by seventeen per cent. The number of available patents through which search must be made is now two hundred and forty per cent. of what it was in 1890. The force relative to the work which it has to do is therefore less than fifty per cent. to-day what it was in 1890.
>
> In order that such a situation may be met at all it is absolutely essential that the best method of classification should be adopted, the classification completed and kept up to date. Yet when I laid all of these facts before Congress and pointed out, as indicated in an earlier section of this report, that at the present rate of reclassification now going on it could not be completed under twenty-five years I succeeded in obtaining no relief whatsoever. Every recommendation that I made during the past year has been refused.

If there could be established *in the national capital* an institute devoted to a study of the development of pure and applied science, is it not important that, even though incidentally to other great consequences, there might be created in both the legislative and administrative branches a new appreciation of the work, the responsibilities, and the opportunities, of an existing establishment, charged under the constitution, "to promote the progress of science and the useful arts"? Certainly those who are now engaged upon the performance of this duty are not all insensible of their limitations, nor of the services of stimulation and cooperation which could be rendered by disinterested and competent men of science.

Bert Russell

Washington, D. C.

A CURE FOR SHOCK?

At a meeting of the Massachusetts Medical Society on June twelfth in Boston, Professor Walter B. Cannon, Shattuck lecturer in lieu of Dr. R. P. Strong (although both are now in France), detailed the probable physiology of traumatic and surgical shock, and suggested a possible cure. Dr. Cannon sees the essential primary condition in shock to be the vaso-motor trapping of too much of the body's blood by the splanchnic veins—capacious enough to contain all the life-blood of the or-

ganism. On one side are the myriad strongly constricted arterioles and, preventing the blood's escape, the capillaries of the liver intervening between the veins and the vena cava.

Dr. Cannon's plan to restore this essential blood to the systematic circulation, including that of the dying central nervous system, is to inject into the peritoneal cavity a properly adapted solution of some powerful vaso constrictant, preferably pituitrin. The expectation is that the hormone will osmose from the outside of the omenta through the thin connective tissue coverings of the veins and, by forcing the constriction of the latter, impel a liter or more of necessary blood into the badly depressed vital organs.

Dr. Cannon is in France, with his assistant, putting this theory into human use. The whole world will wish him the best of success.

G. V. N. D.

CAMBRIDGE

SCIENTIFIC BOOKS

The Mosquitoes of North and Central America and the West Indies. By L. O. HOWARD, H. G. DYAR and F. KNAB. (Carnegie Institution of Washington.) Vol. III. 1915. Vol. IV.. 1917.

The final part of this great work has at last been issued, amid general rejoicings from those interested in medical entomology, since it contains a full account of the malaria-organism carrier, *Anopheles*. The two parts containing the descriptive matter and synonymy total 1,064 pages, and the treatment is as full and exact as it could be made. Under each species is a full list of references to literature, followed by copies of the original description and the descriptions of the synonyms, if any. Then comes a detailed new description of the adult insect, and of the early stages when known, followed by a full list of the localities from which specimens have been received or recorded. Finally, there is a discussion of the synonymy and relationships. The yellow-fever mosquito alone takes over sixteen pages. The reader finds before him practically all that is known of the species treated, and the book will stand as a model of exhaustive discussion and clear presentation.

Some difference of opinion will exist regarding the names of some of the species. The most troublesome case is that of the yellow-fever mosquito. This important insect has generally been known as *Stegomyia fasciata*, or simply as *Stegomyia*, which has almost become an English word. The name *fasciata* being preoccupied, the name *Stegomyia calopus* was substituted; but Dyar and Knab regarded *Stegomyia* as part of *Aëdes*, and called the species *Aëdes calopus*. As such it appears in the work reviewed, but a footnote is added, pointing out that *Culex argenteus*, proposed in 1787, is the oldest name. Hence we are to write *Aëdes argenteus*. Mr. F. W. Edwards, of the British Museum, maintains *Stegomyia* as a genus, and according to this plan it will be *Stegomyia argentea* (Poiret). It is admitted that *Stegomyia* is very different from the type of *Aëdes*, and evidently the question whether it should be generically separated is one concerning which there may be legitimate difference of opinion. Under these circumstances, in view of the general usage by medical authorities, it would seem better to recognize *Stegomyia*.

Another sort of difficulty arises from the mistakes of identification which have resulted from the poor descriptions of early authors. Thus the common species described at great length as *Culex territans* Walker, and so referred to in numerous works, is now said by Mr. Edwards, who examined Walker's type, to be actually quite distinct. It takes the name *Culex saxatilis*, and the real *territans* is what has gone as *Culex restuans* of Theobald. The result of this correction will be that when *Culex territans* is referred to, it will be difficult to tell which of the two species is intended, and confusion must follow. Walker's description was quite insufficient for determination, and under these circumstances it would seem proper to sink the name as unrecognizable. The two insects concerned will then stand as *C. saxatilis* and *C. restuans*.

The *Anopheles quadrimaculatus* of authors is also involved in difficulties. It is described

under this name in the book, but at the end of the account the opinion is expressed that Say's *quadrimaculatus* was really the species described as *Anopheles occidentalis*. This is determined from Say's locality, "North-west Territory." Accordingly we are told that *Anopheles guttulatus* Harris should be adopted, although it was published without any description. This seems inadmissible, and we turn to the next available name, *A. annulimanus*, which "is said" to belong here. But after all, the *quadrimaculatus* of authors occurs as far northwest as Wisconsin, and it does not appear perfectly evident that it is not Say's insect. *A. annulimanus* was also from Wisconsin.

The full citation of localities is much to be commended. It might have been still fuller, but for the unfortunate habit of a former curator, of throwing away what he regarded as duplicates. The present reviewer eagerly turned to this mass of information for light on a practical problem in which he is interested. In the course of the war, it will be necessary to establish large camps and hospitals, partly for training purposes, partly for wounded and invalided soldiers, partly, no doubt, eventually for prisoners. It will be desirable to place these camps or hospitals near distributing centers, but also in regions where the climate is favorable and the malaria mosquito is absent. In the presence of *Anopheles*, men carrying malaria organisms in their blood will constitute a menace to other soldiers and to the civilian population. The exact distribution of *Anopheles* accordingly becomes a matter of importance. On mapping the recorded distribution from the new volume, it was found that records were lacking from Quebec, Rhode Island, Vermont, Delaware, Ohio, Alabama, Iowa, Oklahoma, Nebraska, N. Dakota, S. Dakota, Minnesota, Wyoming, Montana and Saskatchewan. Obviously in the majority of these cases the absence of records is due to lack of sufficient collections. Ohio, Delaware, etc., certainly possess the same *Anopheles* as all the surrounding states. There is, however, a real blank on the map, covering Montana, Wyoming, the eastern part of Colorado, Nebraska, the Dakotas, Iowa and Minnesota. It is not to be supposed that *Anopheles* is actually absent over all this area, but it must be relatively scarce, and over a considerable region is probably altogether lacking.

In New Mexico, the southern and Pacific *A. pseudopunctipennis* gets as far north as Las Vegas Hot Springs. In Colorado, *A. quadrimaculatus* comes over from Utah as far as Delta County, on the western slope. This same insect is common eastward, in Illinois, Indiana, Missouri, etc., and it may occur right across the country. More exact investigations, which are planned, may be expected to determine whether this is the case.

In order to form an opinion whether the apparent lack of *Anopheles* in the region just cited was wholly due to the absence of collections of mosquitoes, I listed all the reported species of the states involved. Montana has no less than ten recorded species, Colorado six, North and South Dakota each three, Nebraska two, Iowa seven, Minnesota and Wyoming one each. Evidently collecting is greatly needed in several of these states, and the apparent absence of *Anopheles* requires confirmation. It is to be remarked, however, that if it should prove to be scattered here and there over the western plains and valleys, it will probably be absent in several localities, and often when present so localized that it can readily be exterminated.

It is a singular thing that there seems to be an almost total absence of any endemic mosquito fauna in the central arid region. The few species found are mostly widespread, the only partial exceptions being a few *Aëdes*. *A. nigromaculis* is peculiar to the arid western-central regions, south to the Mexican State of Chihuahua. *A. fletcheri* belongs to the prairies of western Canada and adjacent United States. *A. idahoensis* is from Idaho, Montana and Nevada, and *A. aldrichi* so far from Idaho only. There is no series of peculiar forms, such as Dyar found in the mountains of California, or such as occurs in parts of Canada.

The total number of species described from

the region indicated in the title is 398. We may surmise that no less than 500 actually occur.

T. D. A. COCKERELL
UNIVERSITY OF COLORADO,
BOULDER,
May 13

NOTES ON METEOROLOGY AND CLIMATOLOGY

PHENOLOGY

PHENOLOGY is the study of the periodic phenomena of plant and animal life in their relation to weather and climate. Phenology is most important in forestry, agriculture, horticulture and ornithology. In spite of the wide application of such data there has been but little phenological observing done in this country. The extent of such work here and abroad is summarized by J. Warren Smith in Monthly Weather Review, Supp. 2, October, 1915, in connection with the remarkably long and extensive records of Thomas Mikesell at Wauseon, Ohio. These Wauseon records began in part in 1869 and are published including 1912; complete data are given concerning 114 kinds of wild plants, 48 forest trees, shrubs and vines, 16 kinds of fruits, 20 field and garden crops (with yields of some), and the temperatures, rainfall, frosts and first and last snows. In parts of Europe similar records though of fewer plants have been taken by many observers in the British Isles for more than 20 years and in Hessen 33 years.[1]. Ihne[2] in charge of the latter has made a map of phenological spring, and also compared the distribution of population with the phenological maps.

The Bureau of Entomology and the Forest Service are studying phenology as an aid in planting and cutting trees and in the control of pests.

Dr. A. D. Hopkins, of the former, has formulated in a general way the law of phenological variation as follows:[3] "The average variation in the dates of a phenological phenomena of a species is in uniform proportion to the variation in the controlling factors of climate." The general average is the only one for drawing reliable conclusions. A variation of 4 days is to be found with a difference of 1° in latitude, 400 feet in altitude, 5° in longitude westward, or 1° F. The longitude variation seems to be connected with the increasing dryness and strength of sunlight for the Central United States, and with the warmth of the Pacific as the west coast is approached. Departures from the theoretical are the result of local factors. Prevailing sunshine, aridity, absence of large bodies of water, warm ocean currents, prevailing warm winds, S., S.E. and S.W. slopes, narrow summits or plateaus of hills and mountains, broad valleys, open forests, barren or sandy and dry soils—these are accelerating; the opposite conditions are retarding. The size of departures are roughly as follows: error in interpretation, 2 days; southern or northern slopes 1 to 4 days, other retarding or accelerating factors, 1 to 4 days, early and late individuals 1 to 8 days, coastal influences 10–14 days.

The results of collection made by the Forest Service of a large amount of phenological data on 72 common trees in the eastern United States is published in Monthly Weather Review, Supp. 2, October, 1915, pp. 5–9 incl., "A Calendar of the Leafing, Flowering and Seeding of the Common Trees of the Eastern United States," by George N. Lamb. The dates are given only for the extreme north and south limits of their ranges. Further cooperation in the collection of such data is desired by the Forest Service.

In agriculture, phenology contributes not only to the control of pests, but also is of use in determining the proper dates for planting certain crops. On the basis of a thorough study of the Hessian fly at one or more control stations in West Virginia, Dr. Hopkins was able to construct a map and table with which if he knew his location and altitude a farmer could plant his winter wheat during a short period immediately after the usual disappearance of the Hessian fly. In the spring, wild plants are used by many to indicate the proper

[1] Quart. Jour. Roy. Meteorological Soc., J. E. Clark—13 common plants, 6 birds, 5 insects, more than 100 stations.

[2] "Arbeiten der Landwirtschaftskammer für das Grosherzogtum Hessen."

[3] "Report on Forest Trees," 1914.

dates for planting. Thus, "when the silver maples begin to put forth their leaves and the catkins appear on the willows and poplars, nature is indicating that the season is right for the planting of such vegetables as lettuce, mustard, onion seeds and onion sets, parsley, the round seeded peas, early Irish potatoes, radishes, spinach and turnips."[4] Ten days later beets, carrots, kohl-rabi and a second sowing of peas can be made.

[4] U. S. Dept. Agric. Weekly News Letter, Mar. 24, 1915.

CLIMATOLOGY OF THE PERUVIAN ANDES

DR. ISAIAH BOWMAN has devoted one sixth of his recent book, "The Andes of Southern Peru" (336 pp., New York, 1916) to a well-illustrated discussion of the perplexing diversities of Peruvian climates. There are four climatic belts: (1) the wet, eastern lowlands, covered with heavy tropical forest; (2) the wet, windward mountain slopes, with mountain forest extending up to the cold timber line at 10,500 feet, and in protected valleys down to a dry timber line at 3,000 feet; (3) semi-arid mountains, plateaus and basins, covered with grass, moss and alpine plants; (4) the arid coastal zone of irrigated valleys, barren except along valley floors and on the seaward slopes of low coast ranges.

On the wet, windward mountain slopes the belt of heaviest rainfall is between 4,000 and 10,000 feet. Summer is rainiest, for the force of the trade wind by day is greatly increased by virtue of the greater contrast between the highland and lowland temperatures. In the deep, shut-in valleys of the eastern mountains, conditions of marked aridity are found. The local climates of the semi-arid mountains, plateaus and basins depend on altitude, and thus differ primarily in temperature and winds. The chapter on "Meteorological Records from the Peruvian Andes," adds the daily touch to the preceding general discussion of climate. Extensive diagrams, including daily temperature maxima, minima, variability, and daily rainfall show a tropical steadiness, but, withal, sudden weather changes and considerable differences between corresponding seasons of different years. The diagrams taken from thermograph tracings show vividly the effect on the temperature of changes of wind, the passing of clouds or the inception of storms. The Yale Peruvian Expeditions with the National Geographic Society still maintain some meteorological stations in Peru.

The climates of the coast are the most difficult to explain. Widely accepted are the general explanations of the coastal desert of northern Chile and of Peru: that the deserts are there because the normal trade winds blow over the mountains and on descending are warming, drying winds; and that the cold coastal water intensifies the dryness because any winds thence have little tendency to yield rainfall over a warm land. This cold water is an adjunct of the prevailing offshore "trades," for the warm surface water blown out to sea is replaced by cold abysmal water. In southern Peru, Bowman distinguishes five zones from coast to mountains: (*a*) zone of coastal terraces, rain once in many years; (*b*) zone of fog-covered mountains, rain at intervals of 5–10 years; (*c*) zone of desert plains, rain at intervals of many years; (*d*) zone of steep valleys, yearly rains; (*e*) zone of lofty mountains and plateaus, frequent rains in summer months.

The sea-breeze is the most important meteorological feature of the coast. By day the heating of the land on a slope tends to make an up-hill wind; the heating of the land next to cold water tends to make a breeze on-shore. Combined, these two factors make a wind which blows so strongly that shipping operations in the afternoon are hindered or rendered impossible. Its coming at or before noon is uncomfortably boistrous and dusty. On the coast the highest temperature occurs just before the sea-breeze arrives. The coast range, where present, makes this wind rise abruptly several thousand feet, which generally causes fog at 2,000 to 4,000 feet elevation, and in winter some rainfall. Beyond the coast range however, the air is warmed, and mixed rapidly by convection with the high dry air so that no more condensation occurs until it approaches the western Cordillera. There the topograph-

ically forced ascent of the air again brings it to the condensation point, and at 8,000 feet, rain may come in summer. The rainfall on the windward side of the coast range occurs in winter, for then the land is more nearly the temperature of the water. In summer, even with the sea-breeze twice as strong, the heated land surface warms the ascending air too rapidly for the occurrence of precipitation. As little moisture is lost in summer on the coast range, the relative humidity is higher in the interior, so that as the strong winds drive up the mountains, there is more moisture available for precipitation. With unusual wind frequency from the north, there are heavy coast rains at intervals of four to ten years, for then the cold coast water is replaced by a warmer current.

Throughout Peru, the trade winds are in control: there is the wet windward slope, the semi-arid interior plateau and the arid leeward coast. The extraordinary inner diversity of climate in the eastern mountains is due to the difference in exposure to the trade winds, and to the differences in altitude. The contrasts within the desert coast region are the result of the effect of the topography on the daily sea-breezes of varying strength blowing off the cold Humboldt current.

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SPECIAL ARTICLES

THE DISTRIBUTION OF ENDEMIC SPECIES IN NEW ZEALAND

THE flora of New Zealand is so exceptionally rich in endemic forms that its study promises interesting results if taken up under the modern conceptions concerning the origin of species. It embraces among the angiosperms 902 endemics confined to New Zealand proper against 399 forms of wider distribution, 98 of which are confined to New Zealand and outlying islands. This consideration has induced J. C. Willis to make a statistical study of this flora[1] and to compare it with the results deduced from his similar treatment of the endemic forms of Ceylon.[2]

Willis has proposed a new principle for explaining the distribution of plants in general, which is that "the area occupied by any given species (taken in groups of twenty or so) at any given time in any given country in which there occur no well-marked barriers depends upon the age of that species in that country." This proposition he calls his hypothesis of "age and area." It is intended to convey the idea that adaptation, although it may be of use in determining the frequency of a species within its area, is not in general a factor of wider operation. No results show in the figures which can be attributed to it. Exceptional instances, where this seems to be the case, are almost always the result of changes in environic conditions, made by man, and it is a well-known fact that such rapidly spreading forms invade a country along its roads and railroads, occupying chiefly waste fields and stirred-up soil.

If, however, we leave these out of consideration and concern ourselves only with ordinary wild species, statistical study seems the only means to get average and reliable results. Taken in small groups of, *e. g.*, 10–20 species these statistical results prove to be the same everywhere and in all the larger families. A general cause must govern this phenomenon, a cause which is, at any rate, independent of morphological and biological qualities.

New Zealand is very convenient for determining the area of its species, for the islands are spread out in a long curve running in general north and south for about 1,080 miles, with an average breadth of 100. Therefore longitudinal range can simply be substituted for area and this can be determined by dividing the country by transverse lines at every twenty miles. Moreover, it consists chiefly of two parts: North Island and South Island, which do not show any essential barriers to the spreading of plants, but are separated by a channel broad enough not to be passed by

[1] Dr. J. C. Willis, "The Distribution of Species in New Zealand," *Annals of Botany*, Vol. 30, No. 119, July, 1916.

[2] See the review in SCIENCE, N. S., Vol. 43, No. 1118, pp. 785–787, June, 1916.

species under average conditions. It is assumed that the forms, common to both islands, arrived or originated there before this separation arose.

On any theory some endemic species will be older and others younger. The first may now occupy the whole country, but the latter only parts and the youngest even only small parts of it. Climate and environmental conditions are so uniform throughout the islands that on the theory of natural selection no part of them has a greater chance of producing endemics than others and an equal distribution should be expected. The actual facts, however, contradict this conclusion and show that the endemics with a small distribution are heaped up in the center of the country, whereas toward the north and south they become regularly rarer. The endemics found in the extreme ends are almost only those which occupy the whole or a great part of the range.

This most interesting law of distribution is proven by a series of tables, which elucidate it from different sides and by means of different statistical arrangements. It clearly points to some cause which is independent of the uniform climatic conditions, and also of the special adaptability of the species. It holds for the species of the families and larger general as well as for the whole flora, and for those occurring also outside of the islands as well as for those confined to them. In other words, it governs the distribution of the forms, which originally reached New Zealand from elsewhere and first populated it, as well as that of the native types.

The explanation proposed is this: New Zealand is separated from the nearest land area of important size by an immense stretch of water, and so it is evident that few species can have arrived there in recent times, apart from the influence of man. The species of foreign origin, *i. e.*, of wider distribution, or the "wides" as Willis calls them in opposition to the endemics, must therefore mostly be very old and widely spread all over the islands. This latter fact is borne out by the statistical tables. Now the soundings show, that the shallowest water approaches New Zealand towards the center of the chain of islands. On the view that this place was its last connection with a larger continent, sunk beneath the sea in geological times, we may assume it to be the point from which the spreading of the main part of its present angiospermous flora has begun.

As the wides spread slowly from this center toward the extreme northern and southern parts they must have produced new forms from time to time. The oldest of these may have spread along with them, and now occupy the whole area. The younger forms, however, did not find, as yet, the time to do so; they must still be local forms. About three quarters of the wides, but only one third of the endemics are now found to occupy more than half the length of the chain of islands and this fact shows clearly that the endemics are not better adapted for distribution in New Zealand than the wides.

On the other hand, there are only 30 wides of very local occurrence, *i. e.*, occupying less than 160 miles or 1/6 part of the whole length (1,000 miles), whereas about one third of all the endemics or 296 species are in this condition. It is obvious that for some reason or other the wides could spread, whilst the endemics could not. No theory of adaptation can explain this phenomenon, but it is very simply understood on the ground of Willis's law that the local species are the youngest, and have not, as yet, had the time to secure a wider dispersal on the islands.

I must refrain from dealing with the contents of all the twelve tables and with the discussions of their results. But from the facts adduced it seems evident that the theory of natural selection can not explain the distribution of the angiospermous species of New Zealand, and that this distribution clearly points to some general cause, which must be the same for all families and all arbitrarily chosen groups of plants as well as for the flora of all different countries. The theory of "age and area" seems the only one broad enough to comply with these requirements.

Hugo de Vries

Lunteren, Holland

SCIENCE

FRIDAY, JUNE 29, 1917

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THE SOCIAL, EDUCATIONAL, AND SCIENTIFIC VALUE OF BOTANIC GARDENS[1]

IT is a noteworthy fact that the United States is beginning to appreciate botanic gardens. This appreciation may be relatively superficial as yet, but the superficial is usually the preliminary step that leads to the fundamental. The desirability of botanic gardens was not obvious when large areas in a state of nature were available to almost every one; but when we developed congested populations in cities and made artificial most of our open areas, the thought of botanic gardens began to take form.

Those of you who have traveled in Europe must have been impressed by the multiplicity of such gardens. They began there in the form of monastic gardens, in which the so-called "simples," used in primitive medicine, were cultivated. Then they came out into the open as city gardens, chiefly for the enjoyment of the people and to beautify the city. Finally, they became also scientific, and gradually led to such great establishments as the botanic gardens at Rome, Geneva, and Paris, the great modern gardens on the outskirts of Berlin and Munich, and that greatest of all garden establishments, the Kew Gardens of London. These are but conspicuous illustrations of what almost every European city had developed before we began to think of garden establishments.

I wish to speak of three conspicuous con-

[1] Address delivered at the dedication of the laboratory building and plant houses of the Brooklyn Botanic Garden, April 19, 1917.

tributions that such an establishment can make, not all of which are appreciated as they should be. There is no better audience for this purpose than the friends and supporters of the Brooklyn Botanic Garden, which has achieved more in certain directions than any other garden in the country. I wish you to realize, not only that your support is justified, but also that perhaps you have builded better than you knew. I shall speak of these three contributions in what I conceive to be the inverse order of their importance, in the sense that the superficial, however desirable, is less important than the fundamental.

1. The first is the *social* contribution. "Social" is a very inclusive word. Anything that contributes to the welfare of a community, in any way, is a social contribution. In this sense, the results of education and of religion are also social. I am using the word in no such general sense, however, but simply to include the betterment of city conditions for living.

A botanic garden is a social contribution because it is one answer to the problem of congestion. It is not sufficient to have open spaces, even when those spaces are beautified as parks. There can not be too many of these, but something more is needed. I wonder if you all appreciate what the touch of nature means. It is something more than open space for breathing. It is a kind of elixir that helps men to be *men*. The garden is a museum of nature, not merely an area left to nature. In it there are assembled the representatives of many regions, so that it gives a world contact. It is a great service to give any community the opportunity of such a contact.

The contact with nature presently develops the contact of interest, and interests outside the routine of living, when these interests are worth while, are both curative and stimulating. Then when interest is awakened, and plants are examined as individuals, and not merely as a general population, the wonders of plant life begin to appear. I wonder how many know why leaves are green and flowers colored; why some plants are trees and others herbs; why some trail and climb, and others stand erect. All of this vegetation is the natural covering of the earth, which cities have eliminated. It is the covering that makes your lives and all life possible. I should say, therefore, that the mere presence of a botanic garden in a city is like having the spirit of nature as a guest, and all who become acquainted with this spirit are the better for it.

There is nothing more artificial than city life, and therefore nothing more abnormal. Some are able now and then to renew their contact with the natural and normal, but most are not. A botanic garden brings to the many a touch of what only the few can secure for themselves. You have doubtless developed some very definite and effective ways of expressing the social contribution of this garden to the life and welfare of this community. But to me, speaking in general terms, the conspicuous *social* contribution is to provide the opportunity, and see to it that all the people take advantage of it.

2. The second is the *educational* contribution. It is this contribution to the community that you have developed with remarkable success. Nature is a great teacher when she really comes in contact with the pupil. The notion is too prevalent that knowledge comes from books; that one can read *about* nature and acquire knowledge *of* nature. One might just as well try to acquire knowledge of business by reading about business. Knowledge comes from experience, from contact. We

must distinguish between *knowledge* and *information.* Knowledge is first-hand, obtained from actual contact with the material. Information is second-hand, hearsay, coming from no actual experience. Reading *about* nature, therefore, brings information; contact *with* nature brings knowledge. To serve a community by bringing its children into contact with nature is a great educational service.

Perhaps the most significant contact with nature is the handling of plants. We are seeking now for an army of people with some experience in handling plants; for more people who will cultivate plants wherever space permits. You have been made to realize, in these days of testing our resources, that the most important material problem we are facing as a nation is the problem of food-production and conservation. Food-production has lagged far behind population, and this increasing gap must be closed up. Our science of transportation has far outstripped our science of food-production, so that we have come to depend not only upon a diminishing food supply, but also upon transporting that supply across a continent. To learn to grow plants and to grow them everywhere, especially near our great centers of population, is a crying need.

The development of home gardens, therefore, is not merely a service for social betterment that all recognize, but it is becoming more and more a public necessity. Any institution that gives you and your children this training is not merely an educational institution, but also a public benefactor. A Botanic Garden doing such work is like a power house, radiating energy throughout the community. Such training is an equipment which not only enriches life, but it is also an equipment for service. In providing such an opportunity, a city can do nothing better for its young people and its homes, and through them for itself..

These two contributions, social and educational, seem very obvious, but the third contribution needs fuller explanation.

3. The third is the *scientific* contribution. This I regard as your great opportunity, and I wish to help you realize it. We are a very practical people, and unless we can see immediate returns from an investment, we decline to undertake it. Very few people appreciate what it has taken to make things practical. We speak of fundamental science and practical science; sometimes we call these two phases pure science and applied science. The general impression is that pure science holds no relation to public welfare, and that applied science serves our needs. You should know that all applied science depends upon pure science; that there would be nothing to apply unless pure science had discovered it. If we had only applied science, it would soon become sterile. It is pure or fundamental science that keeps applied science alive, that makes progress possible. For example, if Faraday had not worked in pure science, Edison would have had no basis for his wonderful inventions. And so it is throughout the whole range of the practical things we are using to-day. To neglect pure science and support only applied science would be like wanting children and eliminating parents. When I hear those who are regarded as practical men lauding our practical achievements, which certainly deserve praise, but speaking lightly of work in fundamental research, I think of them as those who would praise the practical electric light and forget the impractical, because unseen, power house. Scientific research is the power house that generates all the energy we apply in developing what may be called the machinery of our civilization.

I wish now to indicate, by a single illustration, how such an institution as this may become a great laboratory for public service. My illustration is intended only to indicate how fundamental research is of the greatest service to public welfare, a source of energy to be called upon and applied as needs arise. It is not intended to indicate the specific kind of work that any given garden should undertake; this may well vary, but it is a good illustration of the value of research work in general.

I have indicated the problem of food production that our nation is facing to-day. In some way our food production must overtake our population. Over a century ago certain men were speculating about evolution. The subject of evolution was not a science, because men were *meditating* rather than *investigating*. Certainly nothing could have seemed farther removed from general human interest than this speculation. About a century ago speculation about evolution merged into the science of evolution when men began to observe the facts upon which such a theory could be based. For a century, observation and inference went on until they had reached the limit of usefulness. Near the beginning of this century, men concluded that the only way to secure further progress was to test by experiment whether one kind of plant could actually produce another kind. In observing the behavior of plants in breeding, they began to uncover the laws of heredity; and as knowledge of these laws increased, it became evident that this knowledge could be applied to the practical handling of plants, and what we call our revolution in agriculture followed. It is a far cry from a speculation about evolution to the solution of our food problem, but the continuity is unbroken. It is by such essential and generally unrecognized service that scientific research is contributing to human welfare. I wish to be more specific and to indicate some of the ways in which science has solved this food problem.

Through scientific work in the study of heredity, we have learned to multiply the races of our useful plants so that they may fit in more exactly to the variable conditions in which plants must be grown. It is a curious fact that we have been blind so long to the teaching of nature that conditions for plants are not the same everywhere. We have always realized that the natural vegetation of this country is not a monotonous covering. Every change in vegetation indicates a special set of conditions for plant growth, and yet we have been trying to grow the same races of plants everywhere. The result has been that we have gotten maximum returns from some areas, minimum returns from others, and medium returns from the rest. Our total result has been an average. By multiplying races of plants to fit conditions more closely, our total result will not be an *average*, but a *maximum* everywhere. This one suggestion of science will double our production.

One of the most destructive enemies of our crops is drought. On the average our production is cut in half by this enemy. Scientific investigation has shown that it is possible to develop drought-resistant races of all our useful plants. This means the possibility, not only of insuring our crops against drought where they are now cultivated, but also of increasing enormously the area of cultivation, by adding the so-called arid regions of perpetual drought.

Another destructive enemy of our valuable crops is disease. The government has expended millions of dollars in the study of plant diseases, in the hope of reducing the loss. The scientific work of recent years has shown that it is possible to breed disease-resistant races. Plants, like human

beings, differ in their susceptibility to diseases. Some are immune, and others are susceptible. This means that we can cultivate immune races and let the susceptibles perish. We can not handle human diseases in this way. Before what we speak of as the wonderful advance of medicine, we were unconsciously practising selection of the human race for immunity. The susceptibles disappeared and the immunes survived. Now medicine has been so successful that it saves the susceptibles and keeps them mixed with the immunes, so that our human problem is more difficult than it used to be. But we have no such sentiment about plants, and we can cultivate immunity and eliminate susceptibility.

I am told by those who are trained in collecting such statistics that if these suggestions of scientific research can be generally applied, our food production will overtake our population. It is in such ways that the results of science find application. This is not merely a local service, but a national service, and in such a time as this it is a patriotic service.

May I call your attention to the work of the National Research Council in connection with your opportunity. This council has been appointed by the National Academy of Science at the request of President Wilson. Its purpose is to bring into cooperation all of our scientific equipment in an attack upon the problems we are facing. This week we have been canvassing the problems that need immediate attention, and they are to be assigned to various research centers, where properly trained men and adequate equipment are available. I want to include this institution in these assignments. Your opportunity is an unusual one, for already you have many things that are needed. You have the opportunity to respond to this call from your country, and to see to it that research is properly provided for. Such research work not only provides what are called the sinews of war, when war becomes necessary, but it also means progress and power in time of peace. It is this opportunity that led me to say earlier in this address that perhaps you have builded better than you knew.

Do not be misled into thinking that only those problems should be attacked that have been developed by some immediate need. Research is like the exploration of a new country. It must be traversed throughout; all trails must be followed and mapped. Some trails will lead to rich lands and valuable mines; others will not. No one can tell until everything has been explored. Your research work here should mean an exploration of nature as represented by plants, and there is no more important region of nature. The more we know about plants, the more intelligent we become in handling them. I have known scientific explorers who discovered a new country and mapped it, but no one at the time recognized it as good for anything. Years afterwards it was discovered that it was rich in possibilities.

Years ago an Austrian monk, working in his monastery garden, discovered some interesting behavior in the plants he was breeding. He recorded his facts and his conclusions in an obscure journal, and no one paid any attention to it. What could be expected from a monk pottering in his garden? Years afterwards, the contribution was discovered, and to-day it is the basis of most of our work in the study of heredity, and this in turn has made our agriculture scientific. No one knows what may turn up in a garden like this one of yours. It is a gold mine of opportunity. See to it that it is cultivated.

JOHN MERLE COULTER

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THE IDEALS AND OPPORTUNITIES FOR A BOTANIC GARDEN[1]

I HOLD in my hand a rare and, especially on this occasion, exceedingly interesting little volume. Its title is "Address at the Inauguration of the Hunt Botanical Garden, in Brooklyn, N. Y.," delivered in the Athenæum at the vernal exhibition of flowers of the Brooklyn Horticultural Society, on the evening of April 11, 1855, by Francis Vinton. Sixty-two years ago, almost to a day was inaugurated the first effort to establish a botanic garden in Brooklyn.

Apparently no enterprise could have been launched under more auspicious circumstances. Thomas Hunt, after whom the Garden was named, endowed it with fifty thousand dollars in money and one third of the ground which the garden was to occupy, estimated to be worth at that time ten thousand dollars. This was a large endowment and a specially munificent gift for the year 1855.

In addition to Mr. Hunt's endowment, William C. Langley, Esq., gave one third of the land and five thousand dollars in money, while Henry A. Kent, Esq., gave the remaining third of the garden plot and twenty-five hundred dollars in money. The total value of the endowment, in money and land, was thus $87,500, or nearly $10,000 more than the endowment of the Brooklyn Botanic Garden after seven years of existence.

Said the optimistic orator on that occasion:

> Let this night of the inauguration of the horticultural garden ever be the anniversary of the successful enterprise that, year after year, shall bless, more and more, the young and the aged, the rich and the poor, young men and maidens, old men and children, parents and friends, to the latest generation.

Alas, for the best laid plans of mice and men! The institution, apparently so *firmly established, proved to be, not a perennial, but an annual plant. At the close of one year, owing to a combination of circumstances,* the land (located on Fifth and Sixth Avenues, between 57th and 60th Streets) and also the cash endowments, reverted to the original donors, and the Hunt Botanical Garden has perhaps never been publicly heard of in Brooklyn from that year until the present moment.

The institution whose main building we dedicate to-night is the third botanic garden projected within the city limits of Brooklyn. The second one is designated and laid out in the original plans for Prospect Park, but so far as I can learn, its realization was never attempted.

As President Healy has already noted, the first suggestion for our institution came from the late Professor Franklin W. Hooper, but the idea of having it administered as a department of the Brooklyn Institute of Arts and Sciences, in cooperation with the city of New York, was made by Mr. Alfred T. White, chairman of the Botanic Garden Governing Committee of the Institute trustees. Not the least of my pleasures in giving a brief address this evening is to make grateful public acknowledgement, not only of the generous gifts of Mr. White and his two sisters, but of his untiring devotion to the interests of the Garden, and his personal interest in and attention to everything that concerns its welfare, and especially its usefulness to this community.

The first rough plans for the laboratory building and plant houses were prepared by the present director of the Garden at Columbia, Missouri, in January, 1910, and submitted to the architects, Messrs. McKim, Mead & White for study and elaboration.

The appointment of the director, made in February, 1910, took effect on July 1 of the same year. On the fourteenth of the

[1] Address at the dedication of the laboratory building and plant houses of the Brooklyn Botanic Garden, April 19, 1917.

preceding February the Board of Estimate and Apportionment of the city of New York was requested to issue corporate stock of the city for the erection of the building, and the plans and specifications for the first section were advertised for public letting during October and November, 1911.

On January 18 the contract was awarded to Cockerill & Little Co., the lowest bidders. The building was to be completed in 150 working days from April 1, 1912. Excavation began on April 8, but owing to numerous exasperating delays the Garden staff was not able to occupy the first section of the building until September 24, 1913, approximately one year after the date specified for the completion of the contract.

The work of the Garden, administered for over three years from a temporary office in the Brooklyn Museum, had reached such proportions that the small first section was quite outgrown before it was occupied. The small plant houses became greatly overcrowded, both with plants and with classes; our one lecture room and class-room made it possible for us to respond to only a fraction of the demands made upon us by the schools and the general public; part of our library and thousands of specimens of our herbarium were packed away in storage, inaccessable for daily use; of laboratory accommodations we had almost none; further growth was impossible, stagnation was out of the question, for the Botanic Garden was a living institution, young and vigorous.

The state of the city's finances, resulting from the enormous cost of necessary public improvements, made it necessary for the most efficient board of estimate and apportionment the city has ever had to administer the public funds with the strictest economy, making appropriations of corporate stock only for necessary or very urgent purposes. This was the situation confronting our garden in May, 1915, when the chairman of our governing committee, realizing the urgency of our need, and believing firmly in the value of our work to this city, as well as to education and science in general, secured private funds to the amount of $100,000 on the condition that the city appropriate corporate stock in the same amount for the completion of our buildings, and other permanent improvements of the Garden. The terms of the gift were accepted by the city administration, the corner-stone was laid just one year ago to-morrow (April 20, 1916), and to-night we dedicate the building.

One can not help but recall at this time how very recent is the development of scientific laboratories. By whatever way you come to this building this evening you were dependent for your transportation upon an electro-magnet; electro-magnetism was discovered by Faraday in 1831, and the laboratory in which he worked was the only research laboratory then in existence. The epoch-making discoveries of the great French physiologist, Claude Bernard (about 1870), were made in the damp, unsanitary cellars of the Collège de France. It was indeed impossible, says M. Vallery-Radot, to dignify these cellars by the name of laboratories; Bernard himself called them "scientists' graves"—a prophetic name, for it was Pasteur's opinion that the disease which caused the death of Bernard was induced by the unhealthful conditions in which he was obliged to work. The laboratory of the Sorbonne was equally bad, dark and damp, and several feet below the level of the street. As late as 1871[2] there

[2] The first botanical laboratory in the United States for undergraduate instruction was introduced at Iowa Agricultural College (Ames) by the late Professor C. E. Bessey, in 1873. The laboratory method for advanced students is said to have been introduced the year previous at Harvard, but this was unknown to Bessey.

was no botanical laboratory of any sort in the United States. The museum and laboratory building of our sister institution, the New York Botanical Garden, completed in April, 1901, was the first building of any considerable magnitude in this country constructed for the sole purpose of botanical instruction and research.

What a change, and what an appropriate and heartening change, in the past twenty-five or thirty years, for now all of our better colleges and universities are planning adequate housing for their botanical work, and in many institutions this ideal has already been realized.

As many of you have already seen, the architects have made this a building of great beauty. A well-known magazine recently published a view of the Woolworth building, in New York, entitling the picture "a cathedral of commerce." And why should not commerce, and science which promotes commerce, have their beautiful buildings? Nothing has done more to give us a deep insight into divine mysteries, to correct false notions of deity, to produce a sane and wholesome attitude of mind toward the universe and man's relation thereto than the study of science, especially during the past fifty years. I like to think that there is something truly significant in the fact that the architectural motive of this laboratory building was drawn from churches such as are not uncommon in northern Italy.

But what is this building for, and what is a botanic garden? A botanic garden is an institution for the advancement and diffusion of a knowledge and love of plants; the particular purpose of the Brooklyn Botanic Garden is the advancement of botany and the service of the city.

But how, you ask, can a botanic garden serve the city? Without hesitation I reply, primarily by the advancement of botany, secondarily in many related ways. How the means indicated are adequate to achieve the result is still not clear to those who are inclined to think of botany, not as a man's work, as a science fundamental to the oldest and most essential of all human occupations, namely agriculture, but merely as a pleasant pastime for young ladies in a "finishing school," or as a rather heroic method of learning to recognize a few native wild flowers and to pronounce their Latin names. My time is too short and the hour is too late for me to go into details, but I may briefly illustrate by citing a line of work now in progress here, namely, a survey of the diseases of the trees and shrubs of Prospect Park and the Botanic Garden. During the past ten years the boroughs of Brooklyn and Queens have lost chestnut trees to the value of several hundred thousand dollars through the ravages of a tree disease which no one knows how to combat. Would it not have been worth much more than the annual cost of maintenance of both botanic gardens of the city to have known how to check the chestnut blight, and how to cope with equally destructive diseases now threatening several other kinds of trees?

But of far greater importance than a knowledge of how to grow trees in a city, or how to combat the diseases of crop plants, is the instilling in the general body of our citizens of correct habits of thought and a correct attitude of mind in the face of such problems. To observe accurately, to record faithfully, to reason logically, to keep an open mind, to welcome truth regardless of consequences, quickly to recognize error, to make no compromise with charlatanism—this is the scientific habit of thought and work. It is the only method by which knowledge is advanced; it characterizes all research in this and similar institutions; it is the indispensable spirit of all scientific instruction, both elementary

and advanced; *it is the greatest educational need of to-day.*

Never more than now was our educational atmosphere so surcharged with a clamor for "efficiency," which, in many minds, is synonymous with the idea that the chief end of education is to enable one to get a living. But the scientific habit of mind, briefly outlined above, equips one, not only to get a living, but to live. To belittle the importance of equipping our youth to succeed in some vocation would be folly; it is greater folly not to recognize the importance of equipping them to spend their hours of recreation in something more wholesome and beneficial than movies and cheap vaudeville.

To educate one to think straight and to keep his thoughts in the realm of the useful and beautiful is of more fundamental importance, is more "practical," if you please, than any other end to be sought by education. The knowledge to be obtained by nature study and the study of botany is of large importance, but the by-products of these studies, as here indicated, are the larger values. The work of public instruction as organized at the Brooklyn Botanic Garden affords an additional opportunity for our citizens to obtain such advantages —knowledge in which they are interested so presented as to bring pleasure, to build character, and, in many cases, to serve as the foundation of a successful life work. This is preparedness of the most thoroughgoing sort, for it not only goes to the root of things, but it serves the nation at all times and under all circumstances, in peace as well as in war.

Two writers in a late number of SCIENCE,[3] discussing the recent debate in the House of Lords between Lord Haldane (*pro*) and Lord Cromer and Viscount Bryce (*con*) on the extension of science teaching, and the place of science in education, call attention to the fact that "science is *finding out* and *learning how*," and is not to be thought of in terms of its results. Any system of education that does not provide ample opportunity for training in finding out and knowing how is fundamentally faulty. It is the duty of every state, of every city, to see that its educational system makes suitable provision for this kind of discipline.

Such opportunities, within the realm of botanical science, are afforded at the Brooklyn Botanic Garden by our own classes, taught by members of the Garden staff, by lectures and nature stories for adults and children, and by opportunities afforded here for teachers of the public and private schools of Brooklyn to bring their pupils for a first-hand study of plants in field, conservatory and laboratory. When a boy comes to the Botanic Garden regularly every Saturday for a year or more, clear from Staten Island, a round trip journey consuming from three to three and a half hours, one may be sure that what he receives here partakes of the nature of fascination, and possesses unmeasured importance in the making of his character and in his preparation for a useful career. This is only one illustration of many that might be given, of how our work is appealing to an increasingly large number of young people.

As a result of the present international situation there is now a widespread movement to bring all available land, especially in cities, under cultivation. This phase of preparedness was inaugurated in Brooklyn by the Botanic Garden some three years ago by the starting of back-yard gardens, and the distribution of penny packets of seed. During the past three years we have distributed over 311,000 penny packets of seeds to the children of Brooklyn, and have inaugurated and inspected from 1,200 to 1,400 back-yard gardens. With the more ample quarters made available by our com-

[3] SCIENCE, N. S., 44: 841–844, December 15, 1916.

pleted building, opportunity is afforded for the expansion of this work several fold.

A brief word for scientific research and I am done. There is now nearing completion in this city one of the most stupendous works of engineering ever brought to a successful completion. I refer to the new water supply system. But what would the city say to the proposition that it should confine all of its efforts to building the conduit for this water, and should leave to some other city, or to some county, or to the state, the expense and the work of providing the reservoir and keeping it adequately supplied with water? The answer does not need to be stated.

But now transfer the simile to education. What a sorry spectacle would be an institution such as ours, calling itself educational and scientific, and yet content to be merely a conduit of information procured from a fountain head located elsewhere, and to which it made no contribution. It is the supreme—the supreme—business and duty of an institution like this, to be creative, productive; not merely a purveyor—a channel of distribution. Our debt is to science as well as to the people. We owe it to the people to disseminate knowledge; we owe it to science not to be parasitic on the body of knowledge, but organically connected with it in a relationship of mutualism—of mutually advantageous symbiosis—giving as well as receiving, constantly enriching the storehouse from which we draw. This is the only relationship which makes for healthful vigor, for perennial enthusiasm, for largest accomplishment, for the most valuable and solid service to the community. Does the great metropolis of New York wish otherwise—wish less than this for its educational and scientific institutions? I believe it does not. We are now living in the early years of an epoch when municipal support of the important work of finding out and learning now is to be considered as important and proper a function of municipal government as acquiring water sites and building aqueducts.

In a recent address on "The Support of Scientific Research in a Democracy," Professor James McKeen Cattell called attention to the fact that the manufactures of the city of Pittsburgh and Allegheny county are worth more than three hundred million dollars a year. These manufactures have all been made possible by the applications of science. Ten per cent. of their value—thirty million dollars a year—says Professor Cattell, might to advantage be spent in that city for the future advancement of science under the auspices of the University of Pittsburgh. At first thought, this proposition seems as startling to the "impractical" scientist as it does to the "hard-headed" business man. But why should this not be done?

In a letter from the Secretary of the Board of Water Supply of New York City, I am informed that the land owned by New York City about the Ashokan reservoir covers a total of 15,254 acres. Six thousand of these acres are forested with so-called second growth of white oak, rock oak, red maple, sugar maple, hemlock and white pine. The letter contains this significant sentence: "The chestnut growth is being removed on account of mortality from pests." There have been planted by the city on this watershed over 1,470,000 coniferous trees, more than 1,000,000 of which include six species of pine. The present value of these pine trees may be conservatively estimated at not less than $1,000,000 dollars, and the value increases from year to year—likewise their importance to the city's water supply. It is now common knowledge that some of these species of pine are being attacked by a fatal disease, the blister rust, recently imported into this country from Europe. Damage to the extent of hundreds of millions of dol-

lars is known to be caused every year in this country by imported plant and tree pests. Whose concern should it be to take every possible measure to learn the nature of the pine-tree blister rust which threatens property of New York City to the extent of several millions of dollars? Would it not be a perfectly reasonable business proposition to expend annually 10 per cent. of the value of the trees on the Ashokan watershed in order to ascertain effective means for the control or eradication of a tree disease which may necessitate a replanting of the entire area?

Several million dollars worth of potatoes are consumed in greater New York every year; who should be more interested than the residents of this city in supporting botanical research that has for its object the eradication of potato diseases in Maine, whence a large percentage of our supply is derived?

By the scientific and educational opportunities which it can afford our citizens, by diffusing in this community, and from this community as a center, a knowledge and love of plants, by botanical investigations in the realms of pure and applied science, the Brooklyn Botanic Garden can yearly render to the city of New York a service whose value will be far in excess of any sum of money that will ever be necessary for its annual maintenance.

At the opening of the Pasteur Institute, in Paris, in 1888, the founder of the science of bacteriology, near the close of his address, spoke as follows, smarting as he always did, at the memory of the events of the Franco-Prussian war:

> If science has no country, the scientist should have one, and ascribe to it the influence which his works may have in this world. If I might be allowed, Mr. President, to conclude by a philosophical remark inspired by your presence in this Home of Work, I should say that two contrary laws seem to be wrestling with each other nowadays; the one a law of blood and of death, ever imagining new means of destruction, and forcing nations to be constantly ready for the battlefield—the other, a law of peace, work and health, ever evolving new means of delivering man from the scourges which beset him.

These words seem written for the present occasion. Almost the entire civilized world is at war, but the ultimate triumph of freedom over tyranny, of civilization over vandalism, of right over wrong, may now be confidently predicted; peace, let us hope, is not far distant. In the realm of the intellect there is perpetual conflict of light over darkness, right over wrong, knowledge over ignorance and superstition. But the strongholds of ignorance and superstition, while perpetually yielding are eternally holding out. We shall never know it all, there will forever be ample opportunity for and need of scientific research—of the advancement and diffusion of knowledge. This is man's largest opportunity, the ultimate source of his greatest happiness.

C. STUART GAGER

BROOKLYN BOTANIC GARDEN

THE SCIENTIFIC WORK OF THE BUREAU OF FISHERIES

AFTER most careful consideration of its responsibilities in the present national exigency, the Bureau of Fisheries has determined upon the following principles and plans for its immediate guidance:

1. The service of science to fishery work is of such great possible significance that it would be a serious error to abandon the pursuit of proper scientific investigations.

2. The exigency of the national food situation is such that every practicable and proper effort should be made to bring about a greater production of fish and a better utilization of the available supply.

3. The conflict between the two principles just mentioned is more apparent than real, as may appear from the following statement of the bureau's plan.

4. The bureau will not interrupt important investigations which have been pursued for

periods of years and which must be continued in order to gain the desired results.

5. As between new investigations which may be expected to yield returns after a long period of years and those which may be expected to produce results in time to serve the immediate needs of the country, preference will be given to the latter.

6. In the latter class are studies—biological, biochemical, physiological and technological—relating to the propagation and rearing of fish, the protection of fish, the utilization of fishery products, etc.

7. The bureau is not only utilizing its permanent scientific staff to the fullest extent, but is gladly availing itself of the valuable assistance offered by biologists, physiologists and chemists from various universities.

8. For the immediate present certain economies are being practised. This does not mean a policy of niggardliness; on the contrary, expenditures must in many respects be more liberal than hitherto. It does mean, however, the temporary curtailment or cessation of certain customary activities which can not be continued in a satisfactory manner during the immediate period of necessary readjustment.

More specifically the bureau's plans for scientific work in the near future may be stated as follows:

The marine laboratory at Beaufort, N. C., will not be opened for general investigations during the coming summer. The Woods Hole laboratory, while temporarily closed for general investigations, will have a small special staff for experimental work in the utilization of fishery products. The fish-culture experiment work of the Fairport, Iowa, laboratory bears so directly upon the immediate problems of food supply that the activities of the station will suffer no curtailment, but will be somewhat expanded. In the class of field investigations, some will be continued, some abandoned and some new studies undertaken.

Not as a complete catalogue of investigations provided for, but as illustrating the topics regarded as proper for the bureau's attention at this time, the following may be selected: The relation of fishes to mosquito extermination and to public health; the habits and propagation of salmon in Pacific waters; the natural history, propagation and protection of the blue crab; problems of the oyster industry; experiments in curing fishes; the properties of the roe of certain fishes alleged to be toxic or distasteful; various other investigations relating to the utilization of fishery products; dragon-flies and damsel-flies in relation to the culture of fishes in ponds; aquatic plants in relation to the culture of fishes in ponds; parasites affecting fish culture in ponds, life-histories, and means of control; systematic relations, habits and migrations of salmonoid fishes in the Great Lakes; biological and physical conditions of fish life in enclosed waters; the protection of wood against marine borers; the utilization of marine algæ, and the relation of kelp harvesting to the fisheries.

H. M. Smith,
Commissioner of Fisheries

Washington, D. C.,
June 18, 1917

SCIENTIFIC EVENTS

CONCERNING THE MANUFACTURE OF PHTHALIC ACID AND PHTHALIC ANHYDRIDE

The Department of Agriculture announces that the color investigation laboratory of the Bureau of Chemistry, of this department, has perfected, on a laboratory scale, a new process for the manufacture of phthalic acid and phthalic anhydride. This process, as carried out in the laboratories, appears so promising that it is thought that some manufacturers of chemicals and dyestuffs in this country may be able to supply their demands for these compounds by this process, provided the process can be reproduced upon a technical scale so as to obtain results commensurate with the laboratory investigations.

With a view to helping the chemical industry of this country, the Department of Agriculture hereby announces that it is ready to assist manufacturers who wish to produce these compounds. The expenses of the technical installation and of the labor and materials necessary will of necessity be borne by the firm, individual, or corporation wishing to manufac-

ture the products. The chemists of the color investigation laboratory will assist with expert advice, etc. The department reserves the right to publish all the data obtained from the technical experiments.

Since it seems very desirable that phthalic acid and phthalic anhydride be made available in large quantity in this country at the earliest possible moment, this offer of assistance will not be held open by the department for an indefinite period.

D. F. HOUSTON,
Secretary

U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.,
June 16

THE CROCKER LAND EXPEDITION

DR. HARRISON J. HUNT, surgeon of the Crocker Land Expedition, arrived in New York on June 20, on the Danish steamer *United States* and reported the story of his journey by sledge over the young ice of Melville Bay. He said that the other members of the Crocker Land Expedition were in excellent health when he left them, but that, owing to their supplies being very low, it is imperative that relief be sent to them at once. The Committee-in-Charge had sent Captain Robert A. Bartlett to take command of the sealer *Neptune,* the third relief vessel which has been chartered in behalf of the Crocker Land Expedition.

Doctor Hunt left North Star Bay on December 18, 1916. He was accompanied by another member of the party, W. Elmer Ekblaw.

"The steamship *Danmark,*" said Doctor Hunt, "which had been sent by the Committee-in-Charge, was at North Star Bay when I began my journey south. Mr. Donald B. MacMillan, leader of the expedition, Professor Edmund Otis Hovey and Jonathan Small—another member of the party—were at Etah. Their supplies will last until about the 1st of August and the members will then be dependent upon what walrus and caribou meat they could obtain at Etah. They might also get eider-duck eggs. They have very little coffee, sugar and canned fruits and flour was being rationed out. They may get some supplies from the *Danmark* by sledging a hundred and fifty miles to her. That vessel is in about six feet of ice and possibly she will be freed about the 1st of August. She has stores but is short of coal. I was glad to hear, on my arrival here, that the Committee has already arranged to send the *Neptune,* such help as is urgently needed. Another year in the Arctic would prove a great hardship to the members of the Expedition and might result in fatality."

Dr. Hunt and Mr. Ekblaw left North Star Bay with six sledges and were accompanied by five Eskimos. There was deep snow and the weather was generally bad. When they got out on the ice of Melville Bay they found that the winter had been comparatively open and that the ice, which was three inches in thickness and very porous, was continuously bending beneath them. The long sledge journey of fourteen hundred miles, which took from December 18, 1916, until April 16, of this year, was attended by many perils. Knud Rasmussen, the Danish explorer, who went part of the way with the scientists, as well as old Eskimos, said that the conditions for sledging were the worst they had ever seen. The later part of the journey was undertaken by Dr. Hunt accompanied only by Eskimos, as Mr. Ekblaw remained at South Upernavik.

Dr. Hunt said that from the scientific point of view the Crocker Land Expedition, which was sent out under the joint auspices of the American Museum of Natural History, the American Geographical Society and the University of Illinois, was obtaining excellent results.

Mr. Donald B. MacMillan—the leader of the expedition, has gathered an enormous amount of valuable scientific data. Dr. Hovey, who is probably the best equipped geologist who has ever gone into the Arctic, is in excellent health and spirits and is doing splendid work. He has set up the seismograph at Etah and has arranged to make extensive observations of all kinds.

Captain George B. Comer, the veteran ice-pilot, who was sent north on the first relief expedition, is a man of considerable scientific attainments. When this hale mariner is not engaged in his call-

ng he makes researches in archeology. He is now conducting some most important work in the study of the remains of the ancient peoples of the north.

APPLIED PSYCHOLOGY AT THE CARNEGIE INSTITUTE OF TECHNOLOGY

Professor G. M. Whipple has leave of absence from the University of Illinois for the first semester of the coming year to serve as professor of applied psychology at the Carnegie Institute of Technology and acting director of the Bureau of Salesmanship Research.

Professor Walter Dill Scott, who had originally planned to return to Northwestern University for the next semester, has been given further leave of absence and will remain at Carnegie throughout the year.

A. J. Beatty, Ph.D., Illinois, has been appointed research assistant in the Bureau of Salesmanship Research, and is already engaged in a study of methods used in corporation schools for developing salesmen.

Fellowship appointments include the following: N. L. Hoopingarner, University of Texas; Franklyn Meine, University of Chicago; H. G. Kenagy, University of Minnesota; and C. E. Brundage, Tuck School, Dartmouth.

Beardsley Ruml, Ph.D. Chicago, has been appointed instructor in psychology. L. L. Thurstone has been advanced from assistant to instructor. These, together with Professor J. B. Miner, Professor Kate Gordon and Professor W. V. Bingham, head of the department, will be primarily concerned with mental measurements of students and with research and instruction in vocational psychology.

SCIENTIFIC NOTES AND NEWS

The late Mr. W. Hudson Stephens, of Lowville, N. Y., a life member of the American Association for the Advancement of Science since its eighteenth meeting held in Salem in 1869, by the terms of his will has bequeathed the sum of $5,000 to the association.

Dr. James Mason Crafts, distinguished for his chemical researches and for a time president of the Massachusetts Institute of Technology, has died in his sixty-ninth year.

Yale University has conferred the doctorate of science on Dr. Theobald Smith, director of the department of animal pathology of the Rockefeller Institute, and Sir Ernest Rutherford, director of the physics laboratories of the University of Manchester, former Silliman lecturer at Yale. William T. Hornaday, director of the New York Zoological Park, received the degree of master of arts.

Professor Robert A. Millikan, professor of physics at the University of Chicago, has been made doctor of science by Amherst College. The doctorate of laws was conferred on Nathaniel M. Terry, of the class of 1867, professor of physics and chemistry in the U. S. Naval Academy.

The degree of doctor of science has been conferred by Dartmouth College on Allen Hazen, the civil engineer of New York City.

Bowdoin College has conferred the doctorate of science on A. H. Sabin (class of '76), consulting chemist of the National Lead Company and lecturer in New York University, and on Dr. F. H. Albee, of the class of '99, the New York surgeon.

Professor John E. Bucher, who holds the chair of chemistry at Brown University, has been given the doctorate of science by that institution.

Dr. Chas. H. Herty, editor of the *Journal of Industrial Chemistry*, has been given the degree of doctor of chemistry at the University of Pittsburgh.

The Société Russe de Minéralogie de Petrograd, which before the revolution carried the title Société Imperiale de Minéralogie de St. Petersbourg, held its centenary jubilee in January, 1917, on which occasion John M. Clarke, of Albany, was elected to honorary membership.

The forty-six knighthoods conferred on the occasion of King George's fifty-second birthday include Dr. H. P. Waterhouse and Mr. R. Jones, surgeons, and Mr. R. T. Glazebrook, director of the National Physical Laboratory.

ENGINEER REAR-ADMIRAL G. G. GOODWIN, C.B., has been appointed engineer-in-chief of the British fleet in succession to Engineer Vice-Admiral Sir Henry J. Oram, K.C.B., F.R.S.

FORMER and present graduate students of the department of psychology of Cornell University and a number of his more intimate friends among the faculty met with Professor E. B. Titchener in the Psychological Laboratory on the evening of June 22, to celebrate the completion of twenty-five years of his service to Cornell. A volume of "Studies in Psychology," edited by Professors W. B. Pillsbury, J. W. Baird and M. F. Washburn, was presented to him on the occasion. After the presentation, Professor Titchener responded with some reminiscences of the early days of the Cornell Laboratory, and in conclusion announced that he had declined acceptance of the chair of psychology recently tendered him by Harvard University.

IN the annual report of the visitors of the Oxford University Observatory they express their sorrow at the death of the late Professor Esson, who acted as secretary to the visitors during the whole forty-two years of the work of the observatory. Several lectures to military bodies have been given by the director, Professor H. H. Turner, including lectures in France and in the camps on Salisbury Plain.

THE fifteenth annual session of the South African Association for the Advancement of Science, as we learn from *Nature*, will be held at Stellenbosch, from July 2 to 7, under the presidency of Professor J. Orr. The sectional committees and their presidents will be as follows: A: Astronomy, Mathematics, Physics, Meteorology, Geodesy, Surveying, Engineering, Architecture and Irrigation, Professor W. N. Roseveare; B: Chemistry, Geology, Metallurgy, Mineralogy and Geography, Professor M. M. Rindl; C: Bacteriology, Botany, Zoology, Agriculture, Forestry, Physiology, Hygiene and Sanitary Science, J. Burtt-Davy; D: Education, History, Mental Science, Political Economy, General Sociology and Statistics. Rev. Professor N. J. Brümmer; E: Anthropology, Ethnology, Native Education, Philology and Native Sociology, Rev. N. Roberts. The local secretary is Professor B. van der Riet, Victoria College, Stellenbosch.

PROFESSOR HUGO DE VRIES is preparing, as has been noted in SCIENCE, a new experimental garden and laboratory in Lunteren. He has now transplanted to it the young rosettes of his cultures of *Œnothera*. He plans to continue at Lunteren the work which he had been doing at Amsterdam.

THE official duties of Professor Robert A. Millikan, of the department of physics at the University of Chicago, who has been in Washington during the spring quarter as vice-chairman of the National Research Council, which is acting in close relations with the Council of National Defense, have delayed the appearance of his new volume on *The Electron*, but the University of Chicago Press announces its publication early in July.

PROFESSOR CARL E. SEASHORE, of the University of Iowa, is giving courses at the summer school of the University of California. He offers special work on the relation of psychology to music.

PROFESSOR JOHN WEINZIRL, head of the department of bacteriology of the University of Washington, Seattle, has obtained leave of absence for the coming year and will study preventive medicine with Dr. M. J. Rosenau, of the Harvard Medical School.

A PORTRAIT of the late Professor Raphael Meldola is being painted by Mr. Solomon J. Solomon, in order that copies may be presented to the Royal Society and the Institute of Chemistry.

A MEMORIAL tablet to the late Dr. S. Weir Mitchell was unveiled at the recent commencement exercises of the University of Pennsylvania.

THE death on June 22 is announced of Professor Leverett Mears, head of the department of chemistry at Williams College.

DR. JØRGEN BRUNCHORST, Norwegian minister at Rome, known for his publications in bot-

any and as director of the Bergen Museum, and editor of *Naturen*, died in Rome on May 20, aged fifty-five years.

The American Medical Journal writes: K. A. H. Mörner, professor of chemistry and pharmacy at the Karolinska Medico-Chirurgical Institute of Stockholm, died recently, aged sixty-two. Since 1892 he has been rector of the institute, in which position he participated in drawing up the regulations for the prizes of the Nobel prize committees, and since has been president of the Nobel Medical Committee. Mörner's research and publications in chemistry, especially physiologic chemistry, toxicology and chemical analysis, were notable.

THE United States Civil Service Commission announces an open competitive examination for scientific assistant, for men only, on July 25. Vacancies in the Bureau of Fisheries, at entrance salaries ranging from $900 to $1,400, including a vacancy in the position of fishery expert on the *Albatross*, at $1,200 a year, will be filled from this examination. Further information may be obtained by addressing the Civil Service Commission, or the Bureau of Fisheries, Washington, D. C.

THE New Jersey State Board of Health on June 7 denied the application of Rutgers College, at New Brunswick, for permission to teach and practise vivisection under a law of the state. The denial was based on an opinion from the Attorney General's department that the law in question could not be applied to Rutgers. The act was drawn particularly for the Rockefeller Institute. The Attorney General's department held that it applied only to institutions for scientific research and not to educational colleges or schools.

BY the will of the late Mr. Washington S. Tyler, of Cleveland, $200,000 is designated for Lakeside Hospital. Half of this is to be used for construction, and the income from the other half for the maintenance of a maternity hospital to be conducted in connection with Lakeside Hospital.

WE learn from *Nature* that the late Lord Justice Stirling's herbarium, consisting chiefly of about 6,000 varieties of mosses and liverworts from many parts of the world, has been presented by Lady Stirling to the Tunbridge Wells Natural History Society.

AN opportunity for research work in sociology with some time for other graduate work if desired, awaits a suitable applicant at the University of Chicago and for this $1,200 has been set aside for each of the two years it is expected the investigation will require. By this announcement it is hoped to secure some one already specializing in sociology. Inquiry for further details may be addressed to Professor Albion W. Small, University of Chicago, or to Dr. E. R. LeCount, Rush Medical College, Chicago.

THE *Weekly Bulletin* of the New York department of health has received a condensed report of the vital statistics of the city of Petrograd for the year 1915. The population for that year was 1,850,000. What stands out most prominently in the report is the fact that there were 2,100 more deaths than births reported during the year, thus showing the effect of the war upon the status of the population. The death rate from typhoid fever was over forty (40) per one hundred thousand, as against six (6) for the city of New York during the same period. Four hundred and fifty deaths were reported from smallpox. The death rate for measles, scarlet fever, diphtheria and croup, was far above that of the city of New York. Tuberculosis had a death rate double that of New York. Two hundred and fifty, out of every 1,000 born, died during the first year, as compared with 95 in the city of New York.

RECENT accessions to the University of Arizona Museum include ethnological collections as follows: Eighty-five representative Apache baskets from Governor G. W. P. Hunt, Phœnix; 300 representative Pima baskets from Perry M. Williams, Maricopa; 9 representative Paluate baskets; 12 representative Hopi baskets; 10 representative Hopi pottery; native and ceremonial Hopi costumes; native Navajo costumes, by the University of Arizona

expedition of 1916. The archeological collections include more than a thousand specimens of prehistoric pottery, textiles, weapons and implements from the Cliff and Pueblo ruins of northern Arizona, by the University of Arizona.

THE university senate of Western Reserve University has voted to establish a committee on research to be affiliated with the National Research Council. The committee is composed of Dr. George N. Stewart, chairman, School of Medicine; Dr. Torald Sollmann, vice-chairman, School of Medicine; Professor H. P. Cushing, secretary, Adelbert College; Professor H. W. Springsteen, Adelbert College; Professor F. H. Herrick, Adelbert College; Professor O. F. Tower, Adelbert College; Professor H. A. Aikins, College for Women; Professor Edward Spease, School of Pharmacy.

THE Duke of Bedford, who presided at the annual meeting of the Zoological Society of London, on April 30, explained the steps taken by the council to save food. He said that the total number of animals had been very greatly reduced; first, because they had not replaced any of the large animals which had died during the war; and, secondly, because they had destroyed a number of those which could be replaced in normal times. With the reduction of the number of animals came a corresponding reduction in the amount of food consumed. The principle adopted had been, wherever possible, to cease using food which was also human food. The following details were given:

Meat is limited to horseflesh purchased from the army. Never was the supply more abundant or the quality better, on account of the enormous number of horses in government service.

Potatoes.—We used to use over 15,000 pounds a year—we use none now.

Bread formerly used for the apes and monkeys and some small mammals has been replaced by flour not up to the Board of Trade standard for human consumption, and by ship's biscuits which have made one or two voyages unused and are then rejected as no longer fit for issue. The sale of bags of stale bread to the public for feeding the animals has been stopped.

Wheat is no longer used for any of the mammals or water-fowl. As substitutes we use dari, paddy rice and locust'beans.

Oats.—The quantity used has already been very greatly reduced and the remainder is being successfully replaced by a mixture of split horse beans and maize.

Hay.—The hay used in the gardens consists of those trusses which the army buyer, who buys first, has not selected. Arrangements have been made to use the cut grass from the London parks and squares, and to use larger quantities of foliage.

Fish.—The fish used is unsuitable for human food, except some small quantities required by birds to which salted or stale fish is fatal.

Eggs.—The eggs used for small soft-billed birds are Chinese pickled eggs or undersized imported eggs.

Fruit.—Bananas, formerly used for a very large number of the small mammals and birds, have been, to a great extent, replaced by boiled mangold wurzels and beetroots. Some few small and delicate mammals and birds refuse to take beetroot, but these exceptions are insignificant. The bananas which are still used, as far as possible, are over-ripe ones, unfit for table purposes, but quite nutritious for animals. The dates used are of a quality not up to the Board of Trade standard for human food.

Sugar.—The sugar used for the animals consists of what is known to the trade as "foot" sugar, which is not suitable for human food, and the total quantity amounts to about 5 pounds a week.

Greens.—About 11 bushels are used a week, but these consist of those not sold for human consumption.

UNIVERSITY AND EDUCATIONAL NEWS

THE American Association of University Professors will hold its next annual meeting at Chicago, probably on December 27 and 28.

As has been noted in SCIENCE, Governor Ferguson has vetoed the legislative appropriation for the University of Texas, amounting to one million six hundred thousand dollars for the next two years. It is said that this was done because the board of regents was unwilling to dismiss the president and members of the faculty. There have been various lawsuits, and the attorney general has now given an opinion that the veto is ineffective.

The new Stanford University Hospital, which is being erected at a cost of approximately $500,000, will, it is expected, be ready for occupancy about October 1.

Mr. V. Everit Macy, commissioner of charities and corrections, West Chester County, has undertaken to support three fellowships, of the value of $500, each for work and investigations in the West Chester County penitentiary.

The following changes have been made in the staff of the anatomical department of the Johns Hopkins University: Dr. Florence R. Sabin has been promoted from associate professor of anatomy to professor of histology; Dr. Lewis H. Weed, from associate to associate professor in anatomy, and Dr. Charles C. Macklin, from instructor to associate. Professor O. Van der Stricht, of the University of Ghent, becomes lecturer in anatomy. Dr. Edmund V. Cowdry, associate in anatomy, has resigned to accept the professorship of anatomy in the Peking Union Medical College which is now conducted by the Rockefeller Foundation of New York. Dr. Eldon W. Sanford becomes assistant in anatomy.

Mr. W. G. Waterman, recently assistant professor of biology at Knox College, has been appointed assistant professor of botany at Northwestern University.

Associate Professor William A. Kepner has been promoted to a profesorship of biology in the University of Virginia.

At the University of Minnesota, Henry T. Moore has been appointed assistant professor and Karl S. Lashley instructor in psychology, with salaries of $2,500 and $1,700, respectively.

DISCUSSION AND CORRESPONDENCE

HERITAGE AND HABITUS

The word "habitus" as distinguished from "heritage" was defined in 1913 by Gregory[1] as follows:

> The totality of the cænotelic or recent adaptive characters of an animal may be called its *habitus;* the totality of its palæotelic characters may be referred to as its *heritage.* The habitus tends to conceal remote phylogenetic relationships, the heritage to reveal them. Thus, the diverse habitus of *Thylacinus, Notoryctes* and *Phaseolomys* concealed their remarkably uniform underlying heritage.
>
> The habitus of a race of fishes is the totality of their cænotelic characters, *i. e.,* of all those characters which have been evolved in adaptation to their latest habits and environment. The heritage of a race of fishes is the totality of their palæotelic characters, *i. e.,* of all those characters which were evolved in adaptation to earlier habits and environments and which were transmitted in a more or less unchanged condition, in spite of later changes in habits and environment.[2]

The derivation is, of course, from *habitus,* meaning attire, but by a natural extension habitus is taken to mean among other things, *e. g., facies* (Century Dictionary, p. 2675). The word "habitus" is common property. It is a word of wide significance. Gregory applied it in a limited sense without entirely losing sight of its generally accepted meaning (*e. g.,* habitus of plants).

The terms habitus and heritage may become very useful and be generally adopted among naturalists. The reptilian heritage of ichthyosaurs stands in clearest contrast to their marine habitus; so too the mammalian heritage of bats and cetacea, the primate heritage of man, the avian habitus and diapsid heritage of pterosaurs, the struthious habitus and theropod heritage of *Strouthiomimus,* etc.

Lillie recently uses the term habitus in the same general sense in which Gregory has used it, but the latter gives it a more precise meaning, viz., the totality of all characters evolved in response to the latest or final life zone. "Somatic habitus" as used by Lillie means "general bodily characteristics," while habitus in botany means the sum of the adaptive characters, much as Gregory uses it. These adaptive characters are, of course, inherited.

The words cænotelic and palæotelic, also proposed by Gregory, are perhaps still better terms, because they are self-explanatory to those who know even a little Greek. Cænotelic signifies characteristics evolved during present life habits; palæotelic signifies in-

[1] Gregory, W. K., "(IV.) Convergence and Allied Phenomena in the Mammalia," *Rept. Brit. Assoc. Adv. Sci.,* 1914 (1913), pp. 525–526.

[2] *Ann. N. Y. Acad. Sciences* for 1913, p. 268.

heritance from previous life habits. A cœnotelic character of previous life-zone habitus often becomes a palæotelic character in a subsequent habitus. The "somatic habitus" is generally the expression of the latest life habits.

HENRY FAIRFIELD OSBORN

SCIENTIFIC MEETINGS IN WAR TIMES

A NUMBER of our scientific societies have deemed it advisable "on account of the war" to either cancel or postpone their future meetings and conventions. The American Electrochemical Society disapproves of this action and at its recent board meeting adopted resolutions encouraging rather than discouraging the holding of meetings.

Modern warfare is not so much a matter of prowess at arms as it is a stupendous engineering undertaking. To hasten this war to an early and victorious close our many thousand engineers must bring to bear every possible effort. However, individual, independent effort is not desirable at this time: *concertive* action is absolutely essential for the most efficient service.

In order to expedite the solution of many of the new problems that have arisen as a direct consequence of our martial state, unrestricted discussion of the problems (with but few exceptions) at scientific meetings is bound to give all of us a clearer understanding of the real points at issues, of the urgent needs of our country at this momentous hour.

Meetings of scientific and technical societies have ever served as a great stimulus for their members and have been a "clearing house" for many of the best thoughts and ideas of our professional men.

Let us follow the good example set us by England. Let us encourage rather than discourage the holding of scientific meetings in these war times. When England found herself confronted with a very serious shortage of sulphuric acid, glass, dyes, electrodes, brass, furnaces, etc., the scientific societies arranged symposiums on these subjects and invited not only all of the members to attend, but, further, urged those factory men who were not members to come to the meetings to give their views and experiences and to learn all they could in return.

Just as a large business corporation depends upon the organized effort and efficiency of the several units and departments, so does our government, now more than ever, look to the organized concertive effort of its large engineering bodies for quick and efficient results. Let us continue our meetings and hold them more frequently than ever before.

COLIN G. FINK

THE PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE fourth number of Volume 3 of the *Proceedings of the National Academy of Sciences* contains the following articles:

"A Re-determination of the Value of the Electron and of Related Constants:" R. A. Millikan, Ryerson Physical Laboratory, University of Chicago. The values for the charge on the electron, the Avogadro constant, etc., are given with estimates of the accuracy of the result.

"Body Pigmentation and Egg Production in the Fowl:" J. Arthur Harris, A. F. Blakeslee and D. E. Warner, Station for Experimental Evolution, Cold Spring Harbor, New York. A strong negative correlation exists between the October ear-lobe pigmentation and the egg production of the year.

"Variability of Germ Cells of Sea Urchins:" A. J. Goldfarb, College of the City of New York, and Department of Marine Biology, Carnegie Institution of Washington. The varying behavior of the eggs in the experiments of Loeb, Lillie, Wasteneys and others, was apparently due in large part to variation in the physiologic condition of the eggs they used.

"Transplantation of Limbs:" Ross G. Harrison, Osborn Zoological Laboratory, Yale University. The experiments confirm previous ones, showing that the limb bud is a self-differentiating body: they also show that the laterality of the fore limb may be affected by its new surroundings.

"The Shapes of Group Molecules Forming the Surfaces of Liquids:" Irving Langmuir,

Research Laboratory of the General Electric Company, Schenectady, New York. Cross-sections and lengths are calculated for a variety of molecules. Various theoretical conditions are developed.

"The Importance of the Water contained in the Deeper Portions of the Subsoil:" F. J. Alway and G. R. McDole, Minnesota Agricultural Experiment Station. The moisture of the deeper subsoil will be able to move upward only so slowly and through such a short distance in a single season that it will be at most of no *practical* benefit to annual crops.

"The Transformation of Pseudoglobulin into Euglobulin:" William N. Berg, Pathological Division, Bureau of Animal Industry, Washington, D. C. The loss of pseudoglobulin in the heated sera corresponds almost quantitatively with the gain of euglobulin in the same sera.

"A Case of Normal Embryonic Atresia of the Esophagus:" H. E. Jordan, Department of Anatomy, University of Virginia. A description of the phenomenon for turtles.

"Studies of Magnitudes in Star Clusters, V. Further Evidence of the Absence of Scattering of Light in Space:" Harlow Shapley, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

"The History of the Primordial Germ Cells in the Loggerhead Turtle Embryo:" H. E. Jordan, Department of Anatomy, University of Virginia.

"Studies of Magnitudes in Star Clusters, VI. The Relation of Blue Stars and Variables to Galactic Planes:" Harlow Shapley, Mount Wilson Solar Observatory, Carnegie Institution of Washington. The stellar distribution in the so-called globular clusters has an underlying elliptical symmetry; therefore not only certain nebulæ, our solar system, and the whole galactic system, but even the globular clusters have the oblateness that is general and fundamental in the dynamics of stellar groups.

"Zuñi Chronology:" Leslie Spier, American Museum of Natural History, New York. It has been found possible to establish a chronological scale with applications to American culture-history.

"The Age of the Bolivian Andes:" Edward W. Berry, Geological Laboratory, Johns Hopkins University. There is definite evidence that parts of the high plateau and of the eastern Cordillera stood at sea level in the late Tertiary.

"Large Current-Ripples as Indicators of Paleography:" Walter H. Bucher, Department of Geology, University of Cincinnati. A study of the Cincinnati Anticline.

"The Bearing of Selection Experiments with Drosophila upon the Frequency of Germinal Changes:" Edwin Carleton MacDowell, Station for Experimental Evolution, Carnegie Institution of Washington. A study of extra bristles indicating that they are primarily occasioned by one germinal unit and that no change of evolutionary or practical significance has occurred during fifty generations.

"Pressure Phenomena accompanying the Growth of Crystals:" Stephen Taber, Department of Geology, University of South Carolina. Many phenomena connected with the metamorphism of rocks, the growth of concretions, and the formation of mineral deposits are difficult to explain under any other hypothesis than that growing crystals have made room for themselves by exerting pressure on the surrounding material.

"A New Method of Transforming Esters of α-Aminoacids into their Corresponding Isothiocyanates:" Treat B. Johnson and Arthur A. Ticknor, Sheffield Scientific School, Yale University.

"The Geology of the Fiji Islands:" Wilbur G. Foye, Department of Geology, Middlebury College, Middlebury, Vermont. It can not be said that the modern reefs of Fiji fully support Darwin's theory.

"Dominance of Linked Factors as a Means of Accounting for Heterosis:" Donald F. Jones, Bussey Institution, Harvard University.

"Chemically Induced Crowngalls:" Erwin F. Smith, United States Department of Agriculture. Small tumors have been produced by the application of various chemicals.

"Dynamical Systems with Two Degrees of Freedom:" George D. Birkhoff, Department of Mathematics, Harvard University.

"National Research Council." Membership of committees.

EDWIN BIDWELL WILSON
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THE DECIMAL POINT

STUDENTS of the history of science are continually impressed by the fact that we are truly in scientific achievements the heirs of all the ages with progenitors not limited by any bounds of time or place. The historian John Fiske in one of his essays[1] pertinently remarks:

> The thinker who elaborates a new system of philosophy, deeper and more comprehensive than any yet known to mankind, though he may work in solitude, nevertheless does not work alone. The very fact which makes his great scheme of thought a success, and not a failure, is the fact that it puts into definite and coherent shape the ideas which many people are more or less vaguely entertaining, and that it carries to a grand and triumphant conclusion processes of reasoning in which many persons have already begun taking the earlier steps.

The late and lamented Pierre Duhem in that wonderful work, "Le Système du Monde," with the fifth and concluding volume fortunately completed in manuscript before his recent death, opens his work with a statement to the effect that to trace the origin and genesis of great scientific ideas one is gradually led back to the point where history ceases.

The development of decimal fractions furnishes an excellent illustration of the process mentioned. This story was well told in the *Teachers College Bulletin* of 1910 by David Eugene Smith, in an article entitled, "The invention of the demical fraction." I propose in the present paper to discuss briefly one point of the development, namely the appearance of the decimal point itself; I am adding also an early approach to decimal fractions not known to writers on the subject, based upon a study of a Vienna manuscript of the fifteenth century.[2]

[1] "A century of science, and other essays," New York, 1899.

[2] Codex Vindobonensis 4770.

N. L. W. A. Gravelaar, in discussing Napier's works[3] ascribes to Napier priority in the use of the decimal point. In a further article, "De notatie der decimale breuken," Gravelaar[4] purports to show that Napier was not familiar in 1616 and 1617, with the editions of the "Trigonometry" of Pitiscus which appeared in 1608 and 1612, containing the first appearance in print of the decimal point after Stevin's systematic exposition of the subject of decimal fractions in 1585. To me the whole procedure of Gravelaar borders so closely on the absurd that it would not merit discussion, if it had not been accepted somewhat seriously by other writers.[5]

Eneström, the editor of the Bibliotheca Mathematica, refers[6] to Gravelaar's work, as follows: "Nach Herrn Gravelaar ist Neper der erste, bei dem das Komma (Rhabdologia, 1617) und das Pünktchen (Constructio, 1616) als wirkliche Dezimalzeichen vorkommen; Pitiscus hatte zwar schon ein Pünktchen angewendet, aber dies ist nur als ein Scheidezeichen auzusehen." That the point used with decimal significance in Pitiscus is used with full appreciation by Pitiscus should be evident simply from the fact that at this time the work of Stevin on decimal fractions was widely known; further Pitiscus who uses a bar in the text of his "Trigonometry" of 1608 and of 1612, 13/00024 where the point is used in the Tables, explicitly says of 13/00024, "fractione scilicet 24/100000 neglecto," meaning that in place of 13.00024 he uses 13 as an approximation. Among others von Braunmühl, in his "Vorlesungen über Geschichte der Trigonometrie,"[7] mentions the use of the point in decimal fractions by Pitiscus.

The further fact should be noted that the Constructio of 1616 is the English transla-

[3] *Verh. d. Koningl. Akad. v. Wetenschappen*, Amsterdam, 1899, Deel. VI., No. 6.

[4] *Nieuw Archif voor Wiskunde*, Amsterdam, 1900.

[5] Notably by Glaisher and others in the "Napier Tercentenary Volume."

[6] *Bibliotheca Mathematica*, Vol. VI., third series, pp. 108–109.

[7] Vol. I., p. 225.

tion by Wright of Napier's work, and while it did receive examination by Napier before publication, yet the probability is that the innovation of the decimal point was introduced by Wright. To prove even independent development of the decimal point one would have to show that neither Wright nor Napier had the 1608 or 1912 edition of Pitiscus or any knowledge of the work; the earlier edition of Pitiscus is cited by Napier.

Cantor does refer[8] to the use *in manuscript,* as he carefully mentions, of the decimal point by Bürgi "wahrscheinlich kurz nach . . . August 1592"; even of this use in MS. Cantor says[9] "scheint zuerst," whereas of the use by Pitiscus, he says "angeführte Thatsache, dass Pitiscus in Tabellenanhange seiner Trigonometrie von 1608 sowie von 1612 . . . das Decimalstellen abtrennende Pünktchen benutzt hat." My own feeling is that Cantor mentions Bürgi's use of the point in MS. here to strengthen Cantor's similar claim on MS. evidence for priority for Bürgi in the invention of logarithms.[10]

So far as the complete explanation of decimal fractions is concerned that appears in the work of Stevin, "La Disme," of 1585, which work in Flemish and in French evidently attained rapidly wide circulation. In 1603 Johann Beyer in his "Logistica decimalis" gave the explanation of operations with decimal fractions, using a period in combination with Stevin's method of designating the last order of the last place by a superimposed numeral; thus, $8.79\overset{v}{8}$ for 8.00798. Even in 1616 Kepler in his "Auszug auss der uralten Messe-Kunst Archimedis" used a comma (reversed) quite as we do a decimal point, and gives a sufficiently complete exposition of the use of decimal fractions.

It seems to me to be distinctly unfortunate that Gravelaar should have given, without any ground as I believe I have shown, credit to Napier for a somewhat important contribution to the theory of notation of decimal fractions; certain writers have been misled into according to Napier honor in this field, where no credit is due.

Except for the fact that a question of nationality is introduced we might say that neither Pitiscus nor Napier is worthy of more than a passing note in the history of the development of decimal fractions. Decimal fractions and a more or less convenient notation for the same were historically inevitable, just as logarithms, the analytic geometry, the graphical representation of complex numbers, the calculus, and many other developments of mathematics were inevitable. The earlier steps leading to these processes can now be traced and it is increasingly evident that a succession of thinkers made possible these attainments. Similarly the preparatory contributions of many minds have made possible the simultaneous discovery, frequently, of apparently new mathematical theories.

In the pamphlet by Professor Smith, which I have cited, there appears the reproduction of a page in Christoff Rudolff's arithmetic of 1526 in which there is the computation of interest at 5 per cent., involving fundamentally decimal fractions, using a bar as a separatrix. Concerning this Enestrom says:[11]

In the year 1492 Francesco Pellizzati (or Pellos) published at Turin an arithmetic in which, in one example, division by 100 of 6976587 is given by 69765.87; the point is also used in dividing by 30, 400, 3000, and the like, pointing off one, two, or three places and afterwards writing the remainder as an ordinary fraction. Pellizzati can, however, not be credited with any real comprehension of decimal fractions. The page in question

8 "Vorlesungen," Vol. II., second edition, p. 618.

9 *Loc. cit.*, pp. 617, 619.

10 See Cajori, "Napier Terc. Volume," pp. 101–102.

11 *Bibliotheca Mathematica,* Vol. X., p. 243, in his article, "Über das angebliche Dezimalbruchzeichen einiger der ältesten gedruckten Rechenbücher."

Hier hat Rudolff wirklich mit Dezimalbrüchen gerechnet; wenn man ferner bemerkt, dass der Strich bei Rudolff gewissermassen ein Komma ist . . . so kann man sagen, dass sowohl die moderne Anwendung wie die moderne Bezeichnung bei Rudolff vorkommt . . . ohne dass Rudolff die Tragweite seines Verfahrens verstanden hat.

is reproduced by Smith in his article, above-mentioned, and in the "Rara Arithmetica."

Some time ago in discussing before the American Mathematical Society the "Quadripartitum" of John of Meurs, written about A.D. 1325, I called attention to the fact that this writer also should be included among those who by use of an analogy with the sexagesimal fractions made a near approach to decimal fractions.[12] In the passage in question, which occurs in the twenty-second chapter of the second book, dealing with the extraction of square root, zeros in pairs are annexed to the number whose approximate root is desired. In extracting the square root of 2, six ciphers are annexed to the 2 and the square root of 2000000 is obtained as 1414. At first this is changed to sexagesimal fractions and by successive multiplication of remainders by 60 the root is obtained as 1° (gradus), 24 minutes, 50 seconds, and 24 thirds, or 1 24/60 50/3600 24/216000. The manuscript proceeds, as follows: "Et si vis posses dicere ab inicio cum habuisti hanc radicem 1414 quod unitas que est in quarto loco est sicut integrum et 4 que sunt in tercio loco sunt decima pars integri, et unitas que est in secundo loco est decima decium, et 4 que sunt in primo loco sunt decima decime decime sic 1·4·1·4· Et nota quod istam radicem preinuentam 1414 potes multum bene ponita unitate in loco integrum tres differentias remanentes multiplicare per 10, 20, 30, 40, 50, 60, 70, 80, 90 et semper a producto demptis figuris que excedunt numerum medietatis circulorum, residuas multiplica per illum articulum per quem alias extendisti et hoc facto tociens quod non remaneant nisi tres circuli qui sunt medietas circulorum. Habebis radicem secundum proporcionem integri ad articulum per quem fueris operatus." The statement here that in the 1414 (regarded as the square root of 2, evidently) that the first unit (fourth as counted from the right or ordinary unit's place) is to be regarded as an integer, the following 4 as tenth parts of an integer, the following unit as the tenth part of a tenth, and the final (first, counting in the ordinary way from the right) 4 as tenth parts of the tenth part of one tenth borders closely on the idea of decimal fractions. However, John of Meurs, like so many others who made initial steps in this direction, carried the idea no further.

LOUIS C. KARPINSKI

UNIVERSITY OF MICHIGAN

[12] I am using photographic copies of pages of the Vienna MS. 4770; the passage in question is found on folio 224 verso; the manuscript was probably written in the early part of the fifteenth century, containing also Robert of Chester's translation of the algebra of Al Khowarizmi, recently published in the University of Michigan Humanistic Series.

THE SHORTAGE OF PLATINUM

ACCORDING to a bulletin issued by the U. S. Geological Survey most people are apt to think of platinum as preeminently adapted to settings for precious stones, but the metal is in fact indispensable to many essential industries. Platinum dishes and utensils are absolutely needed in all chemical laboratories, and upon these laboratories all great industries are dependent for guidance. Alloys have been devised for use in the ignition systems of internal-combustion engines, but no substitute for platinum has been found for certain delicate parts of these systems. Platinum and allied rare metals are widely employed in instruments of precision required for making physical tests of materials of all kinds. Probably platinum is now most valuable for its use in the contact process of making concentrated sulphuric acid, which is essential to a great number of industries that are vitally important at all times, and particularly in time of war.

The United States alone annually uses about 165,000 ounces of fine platinum and produces less than 1,000 ounces of crude platinum. Realizing the urgent necessity of increasing the country's production of the metals of the platinum group, the United States Geological Survey, Department of the Interior, has planned an investigation in which L. M. Prindle and J. M. Hill, geologist, will visit places in this country where commercial deposits of these metals may be found.

Native platinum, the metal and sperrylite (platinum arsenide) have been found in basic

igneous rocks at several places in the world but not in commercial quantities. The search for platinum in rocks is therefore not likely to obtain an immediate supply of the metal. Persons searching for platinum ores should remember, however, that the assay for platinum is difficult and apparently can not be successfully made by all commercial assayers. Samples of supposed platiniferous ores should therefore be sent only to the most competent assayers. The United States Geological Survey has received several reports of discoveries of rich platinum ore in which, as the reports state, "the platinum could be detected by the ordinary methods of assay." Such statements should be regarded with great caution, for any platinum ore of commercial grade will doubtless yield traces of platinum if tested by the standard methods employed by competent and reliable assayers.

The platinum supplies of the world, except a relatively small quantity, have been obtained from placer deposits, notably from those of Russia, which have produced about 95 per cent. of the world's output. The largest part of the crude placer platinum now produced in the United States is won by dredges working in California at the west base of the Sierra Nevada, in gravels derived from worn-down lodes and concentrated by natural streams. The greater production from this region than from northwestern California and southwestern Oregon and other places would appear to be due to larger operations rather than to greater or richer deposits.

All the known placer deposits that contain platinum are near areas of basic igneous rocks, and it would seem that the first step in any search for new deposits of platiniferous gravels is to look for outcrops of peridotite, pyroxenite, dunite and serpentine. When areas of these rocks have been found the gravels of the streams that rise in them should be washed to see whether they contain platinum. Most of the heavy concentrates found in gravels that carry platinum are rich in chromite and olivine. The character of the rock of which the gravels were formed may give a clue to their source.

Crude platinum as it occurs in placer concentrates is ordinarily a silvery-white metal, the fresh surface of which could be confused only with that of silver, or possibly with that of iron. It can easily be distinguished from these metals, however, by simple tests, as they are soluble in dilute nitric acid, whereas crude platinum can be dissolved only in concentrated aqua regia, a mixture of three parts of hydrochloric (muriatic) acid and one part of nitric acid. In some placer deposits the grains are coated with a dark film and somewhat resemble the grains of the dark minerals chromite, magnetite or ilmenite, from which, however, they can be separated by careful panning, as the platinum is heavier than any of those minerals.

Platinum will not amalgamate with quicksilver alone, but will amalgamate with quicksilver and sodium. If ordinary quicksilver amalgam is used the flakes of platinum float on the surface and can be removed. If sodium amalgam is used the platinum may be separated from any gold in the amalgam by washing with water until the sodium is converted to sodium hydroxide, when the platinum will come out on the surface, provided the amalgam is sufficiently liquid.

Platinum has a hardness of 4 to 5 and can be scratched with a knife. It is so malleable that it can be hammered into very thin sheets without heating. It is practically infusible, and grains of it can not be melted together, as can particles of gold and lead.

One test for platinum is relatively simple. The metallic particles to be tested are dissolved by boiling in concentrated aqua regia and the resulting solution is allowed to dry. The dry residue is dissolved in hydrochloric acid, and the solution is evaporated by boiling until it becomes a thick mass but is not quite dry. This mass is diluted with distilled water and to it are added a few drops of sulphuric acid and of potassium iodide, which cause it to assume a very characteristic wine-red color if it contains considerable platinum or a reddish-pink color if it contains only a small quantity. This test, though it is fairly delicate, will not

detect traces of platinum if the solution contains large quantities of iron or other elements.

A second test of the residue from the aqua regia solution after it has been dissolved in hydrochloric acid to form the thick mass described is to add to it potassium chloride (KCl), which, if the dissolved residue contains platinum, will precipitate yellow crystals or potassium platinic chloride (K_2PtCl_6).

A third test may be made by adding to the aqua regia solution ammonium chloride (NH_4Cl), which, if the solution contains platinum, will precipitate yellow crystals of ammonium platinic chloride.

The precipitates from the second and third tests are both insoluble in alcohol but are soluble in water and by heating may be reduced to platinum sponge.

The tests described above, though they are comparatively simple and positive if made on single grains, can not be relied upon if the material tested contains other elements than platinum. They should therefore be restricted to grains of a single mineral picked from concentrates obtained by panning a sample of either rock or gravel.

The adequacy of the future supply of platinum in the United States, as far as it can be depends on the results of work of three kinds—first, the determination of our present supply, particularly of unmanufactured platinum metals, in order that it may be mobilized; second, systematic search for new deposits, and third, scientific exploitation of the deposits discovered, to assure their maximum yield. Work of the first two kinds is now being done by the Geological Survey, and it is hoped that work of the third kind—the technologic work—may be in part done by means of federal and private investigations.

A detailed report on the production of platinum in 1916, with information on the world's resources of this metal and hints for prospectors, by J. M. Hill, of the U. S. Geological Survey, is now in preparation and will be ready for distribution in July. Copies of this report may be obtained by addressing the Director, U. S. Geological Survey, Washington, D. C.

SPECIAL ARTICLES

IS THE HOUSE OF TCUHU THE MINOAN LABYRINTH?

WHILE going through a back-number of the *American Anthropologist*[1] the writer's attention was attracted by the figure illustrated in Fig. 1. This was in a short paper by Dr. J. Walter Fewkes entitled "A Fictitious Ruin in the Gila Valley, Arizona." In this he showed that this symbol which was first observed by an eighteenth-century Spaniard scratched in the sand by a Pima Indian did not represent the plan of a ruin as previously interpreted, but was used in some way in a game "the house of Tcuhu" (Tcuhiki).

It was curious but this diagram was familiar to the writer and his familiarity came from a distant part of the world. As shown in Fig. 2 this diagram appears on the reverse of a silver coin of Cnossus in Crete of the Greek Period (B.C. 200–67). In this case the figure represents the Minoan Labyrinth. On other coins from Cnossus it sometimes appears in a square form, but even then it has the same ramifications. A comparison of this Greek coin, with House of Tchuhu when inverted, shows that the two are identical in every respect.

There are three possible explanations for the coincidence. First, these symbols may have arisen independently in the new and the old world. Secondly, the symbol may have originated in the old world and have been transported to the new in pre-Columbian times. Thirdly, that the symbol was introduced into America with the Spanish conquest.

On the one hand, it has been pointed out by Fewkes (*loc. cit.*) that the symbol or something like it was early known to the Pima Indians, as the diagram in slightly modified form appears scratched on the adobe wall of the Casa Grande ruin among obviously Indian pictographs. On the other hand, it is possible that this diagram may have had a Spanish origin.

While it is quite generally accepted by American ethnologists that such simple forms

[1] N. S., Vol. IX., 1907, p. 501.

as the cross, the swastika, the wall of Troy, etc., arose in the new world as well as in the old; yet it is hard to believe that such complicated labyrinths similar in every detail could have had separate origins. Similar environments often call forth similar responses in different organisms. In such cases the similarities when carefully analyzed are found to be superficial. The details will not agree. In this case, however, the agreement is exact.

Again there is a possible question that the figure from Fewkes is not of genuine Pima origin. A brief history of this symbol will make this clear. It seems that an unknown Spanish traveler visited the Pima country in the year 1761 or 1762. An account of this visit exists in the form of a manuscript.[2] On

Fig. 1. After Fig. 34, *American Anthropologist*, Vol. IX., 1907, p. 511 (inverted).

Fig. 2. After a Coin from Cnossus in Crete 200–67 B.C.). (Cat. of Greek Coins in British Museum, Vol. 1887, Plate VI., Fig. 5.)

the margin of one of the pages of this manuscript appears the figure which I have reprinted from Fewkes (Fig. 1). According to the unknown Spaniard the Pimas draw the symbol on the sand. He stated that it represents "a house of amusement rather than that of a magnate." As no ruin has ever been discovered with such a ground plan, Dr. Fewkes was led to question an old Pima concerning it.

When Higgins (the name of the Indian) was shown the figure and told the opening lines of the quotation (from the Spanish narrative), the last clause being withheld, he responded that he knew of no ancient house in that region which had a ground plan like that indicated in the figure. He was acquainted with a children's game that employed a similar figure traced in the sand. The Pimas, he said, call the figure *Tcuhuki*, the house of Tcuhu, a cultus hero sometimes identified with Moctezuma.

A search in Russell's work on the Pima Indian[3] and Culin's "Games of the North American Indians"[4] failed to discover a description of such a game. However, Russell did describe a game called *Tculikwikut*, a dart and ring game in which count is kept by means of little stones. These are moved on a diagram made up of a series of small holes in the sand arranged in the form of a whorl arising from a center called *Tcunni Ki* (the council house).

According to Russell *Tcuhu* in the mythology of the Pima is Gopher, who dug the spiral hole through which the Pima clans came up from the underworld. From this it seems possible that both Russell and Fewkes were dealing with the same game. Strength is given to this idea by the fact that Dr. Fewkes showed "Higgins" the diagram and the Indian said that it was the House of Tcuhu. The Indian did not draw the diagram. He may have simply recognized the spiral character of the labyrinth and not have considered the details.

With such fragments of evidence and with so many gaps to be filled it would be premature to draw any conclusion as to how this complicated symbol happens to be found in both the old world and the new. The writer publishes this in hopes that some reader will also be familiar with the symbol and can aid in its interpretation.

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[2] Rudo Ensayo.

[3] Twenty-sixth Ann. Rept. Bur. Eth.

[4] Twenty-fourth Ann. Rept. Bur. Eth.